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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXVIII DECEMBER, 1932 No. 6

THE TREATMENT OF EPITHELIOMA OF THE SKIN*

INDICATIONS FOR RADIUM THERAPY

By LAURENCE TAUSSIG, M.D.

SAN FRANCISCO, CALIFORNIA

MANY methods have been proposed for the treatment of epithelioma of the skin. Most skin neoplasms are seen early and are relatively benign. The essential features of a satisfactory treatment for skin cancer are complete destruction of the lesion associated with the least possible sacrifice of normal tissue. Desirable but less essential features are simplicity, lack of pain and a good cosmetic result.

Among the methods which have enjoyed a considerable vogue are:

1. Surgical removal:
   (*a*) By the knife.
   (*b*) By the curette.
2. Thermic destruction:
   (*a*) Actual cautery.
   (*b*) Surgical diathermy.
3. Chemical destruction:
   (*a*) Arsenic.
   (*b*) Zinc sulphate.
   (*c*) Chromic acid.
   (*d*) Trichloracetic acid.
4. Radiation:
   (*a*) Roentgen rays.
   (*b*) Radium.

All of these methods or combinations of them are capable, when properly employed, of curing a large percentage of the epitheliomas of the skin and each of them is the treatment of choice in special instances.

GRADE OF MALIGNANCY

The grade of malignancy of a particular skin growth varies with the histopathology, the physical type of growth, with the stage in which it is first seen, and with its location.

It is well known that the basal cell epitheliomas are much less malignant than the squamous cell type. The clinical characteristics of each are usually quite distinctive, but frequently a clinical differential diagnosis cannot be made with certainty, especially in the early cases. The growths which develop slowly and those which tend to evert are less malignant than the ones which develop rapidly and those that tend to infiltrate. A neoplasm which is first seen early in its development is definitely more amenable to successful treatment than if it is not seen until its later stages. New growths on the back of the hand and those on the external ear are usually of the squamous cell variety, but they tend to grow more slowly and to metastasize later than those showing the same histological picture located on the face and neck. From the above it is apparent that the treatment of choice for the majority of epitheliomata should be capable of curing the largest percentage of the most malignant type.

* From the University of California Medical School, Department of Dermatology. Read in a Symposium on Cancer of the Skin' Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9–10, 1932.

ROUTINE THERAPY

During the past few years most of the skin cancers seen by us in the Dermatological Clinic of the University of California Medical School and in our private practice have been treated by curettage followed by electrodesiccation or actual cautery under novocaine anesthesia. This method has a number of outstanding advantages. In the first place, sufficient tissue is usually obtained to provide material for a microscopical diagnosis, a feature which is helpful in determining the prognosis, and instructive in that the clinical diagnosis is checked. In the second place the curette indicates in a decided manner the extent of the involvement, because the neoplastic tissue is more pulpy than the surrounding normal tissue. Electrodesiccation or actual cautery has been found most satisfactory in cauterizing the base and completing the destruction of the remaining neoplastic tissue. In very small lesions a supersaturated solution of trichloracetic acid is sometimes used as the cauterizing agent. This type of treatment is simple, it can be done rapidly and painlessly in the office or clinic, and there is rarely much pain or discomfort during the healing period which usually takes from three to six weeks, depending on the size of the lesion. This form of therapy may be repeated if a recurrence occurs subsequently. The chief objection to this form of therapy is the occasional production of a hypertrophic scar. This occurs in a relatively small number of instances.

CONTRAINDICATIONS TO RADIUM THERAPY

During the early period of the development of radium therapy it seemed likely that this form of treatment would supplant all others. As the years have passed it has become increasingly evident that there are a number of drawbacks to radiation as a universal treatment for all superficial epitheliomas. In the first place, it was determined that the squamous cell epithelioma was much more radioresistant than the basal cell type, which was especially unfortunate, in view of the fact that the first is very much more malignant in its course. In the second place, if the growth recurs following a course of radium therapy, further irradiation results in the production of an atrophic scar with telangiectasia and even keratoses which later may become malignant. Furthermore, it has been found that in instances in which cartilage or bone is involved, irradiation in effective dosage is apt to produce painful and intractable reactions. This fact makes it inadvisable to irradiate growths of the ear or of the ala nasi. Experience has shown that radium treatment is to be considered one of the methods of destroying skin malignancy but that it is by no means universal in its applicability in this field.

INDICATIONS FOR RADIUM THERAPY

There are certain instances of skin neoplasm in which radium is decidedly the treatment of choice. The best examples of these are the growths which occur on the edges of the eyelids. In these it is of prime importance to save as much of the normal tissue as possible, to avoid the necessity of extensive and difficult plastic surgery. Most of the lesions occurring in this location are of the basal cell type and relatively radiosensitive. On account of the advantages of successful irradiation in these cases, it should be used, providing there has been no previous radiotherapy. The radium may be applied in the form of a plaque, tubes of radium or radon, or intratumorally in the form of gold seeds of radon or radium element containing needles. The exact technique is unimportant, but it is essential that the maximum dose should be administered at once, bearing in mind the fact that if the one treatment or course of treatments is unsuccessful, subsequent radium therapy is not safe. My preference in this type of case is for the use of buried gold seeds of emanation. The dosage approximates a seed for each cubic centimeter of neoplastic tissue, each seed containing about 2 mc. and screened with 0.3 mm. of gold.

Another group of cases in which radium radiation may be the treatment of choice

comprises those occurring on the face which have not been previously treated and which seem to belong definitely to the basal cell group. This is particularly true in patients in whom the cosmetic result is of special importance. In this group of cases moderately screened surface radiation is usually indicated. I usually employ radon tubes in this type of case, using one tube for each square centimeter of surface to be irradiated. The tubes are of silver and have a wall thickness of 0.5 mm. They are further enclosed in rubber tubing 1.0 mm. thick. From 40 to 60 millicurie-hours is given for each tube. Here again it is essential that subsequent recurrences should not be irradiated.

A third group of cases in which radium is often the treatment of choice is that consisting of basal cell epithelioma occurring in nervous, old or debilitated subjects in whom the relatively simple and painless operation under local anesthesia may present considerable difficulty.

The postoperative use of radiation is a procedure which is particularly difficult to evaluate. On purely theoretical grounds it would seem to be a logical procedure. In discussing the treatment of skin growths by curetting and cauterizing the base, I pointed out that one of the objections which could be raised was the possibility of occasionally producing a hypertrophic scar. We know that radiation is a satisfactory treatment for keloid and it would seem logical to expect that the routine use of radium postoperatively might very well decrease the likelihood of this scarring. In addition it might well be expected to decrease the number of recurrences. Up to the present we have restricted postoperative irradiation to special cases. These were instances in which we had reason to believe that hypertrophic scarring was likely to occur and those in which the growth was apparently unusually malignant or extensive. The technique is similar to that followed in primary irradiation of the surface type except that the dosage may be considerably smaller.

CONCLUSIONS

1. Radium therapy is not the treatment of choice for the majority of epitheliomata of the skin.

2. Radium may be indicated in:
   - (*a*) Previously unirradiated epitheliomata of the lids.
   - (*b*) Previously unirradiated basal cell epitheliomas of the face when the cosmetic result is of special importance.
   - (*c*) Basal cell epitheliomas occurring in nervous, old or debilitated patients.
   - (*d*) Postoperative treatment of either basal or squamous cell epitheliomas in conjunction with some other destructive method.*

* For discussion see page 742.

RADIATION THERAPY OF CANCER OF THE SKIN*

By MAX CUTLER,† M.D.
CHICAGO, ILLINOIS

CANCERS of the skin constitute a favorable group of neoplasms for radiation therapy, first, because their superficial situation renders them readily accessible, and second, because they are radiosensitive. Being an external lesion, cancer of the skin can be easily recognized in its early stages. It is indeed surprising that in spite of these favorable factors the mortality from this disease still assumes considerable proportions.

In the last three or four years patients, impressed by the educational propaganda for early diagnosis, have consulted the medical profession in the relatively early stages of the disease.

Physicians undertaking the treatment of skin cancer have sometimes failed to appreciate the seriousness of apparently insignificant lesions. The most common error that is committed is the use of small, inadequate exposures to roentgen rays or radium leading to the establishment of a radioimmunity. The failure of the first radiation attempt renders further radiation therapy exceedingly difficult and hazardous, and markedly reduces the chances of cure. The importance of effecting a complete sterilization of the tumor process at the first irradiation is not sufficiently appreciated.

It is my purpose in this communication to call attention to several phases in the treatment of skin cancer which merit special consideration.

PATHOLOGIC CONSIDERATIONS

Epidermoid carcinomata constitute the great majority of skin neoplasms. The usual classification into basal cell and squamous cell types may be supplemented by a third group composed of intermediate forms. The basal cell type is reputed to be more radiosensitive than the squamous cell type. This conception has been challenged on the grounds that the greater radiosensitivity of basal cell carcinoma is apparent and not real. The apparent radiosensitivity of basal cell carcinomata is explained by the fact that these lesions are superficial and do not infiltrate as rapidly and deeply as the squamous cell type, and the better results in the basal cell forms are readily explained by the failure of this histologic type to metastasize.

Adenoid-cystic epithelioma may be regarded as a subvariety of basal cell carcinoma. Although usually possessing the same low degree of potential malignancy as basal cell carcinoma, the adenoid-cystic type may exhibit fully malignant features and metastasizing properties. Spies has called attention to this feature of the disease. In one example, local excision of an adenoid-cystic epithelioma of the nose was followed seven years later by widespread skeletal metastases and death of the patient. Careful microscopic study of the histologic structure usually gives warning of the more malignant character of some of these tumors. Mitoses are numerous and nuclear abnormalities pronounced, in contradistinction to a uniform arrangement and staining and rarity or absence of mitoses found in typical basal cell carcinoma.

Excellent results have been reported following roentgen treatment of cancer of the skin. In general, however, radium is the method of choice and the discussion in this communication will be limited to radium therapy.

Until recently squamous cell carcinoma has been described as being radioresistant and on the basis of this supposition surgery and electrocoagulation have been proposed as the preferred therapeutic procedures. This conception has been demonstrated to

* Read in a Symposium on Cancer of the Skin, Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9–10, 1932.

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be fallacious. Defining a radiosensitive tumor as one whose cells may be completely destroyed by irradiation without permanent damage to the tumor bed, squamous cell carcinoma falls within the group of radiosensitive tumors. An adequate dose of gamma radiation correctly applied to a squamous cell carcinoma of the skin results in a complete destruction of the lesion and a preservation of the tumor bed. In order to accomplish this result with certainty the irradiation should be prolonged, preferably over a period of several days. The prolongation of the irradiation which appears to be important in the treatment of squamous cell carcinoma is less important in the treatment of the basal cell forms. This difference is probably due to the superficial character of the basal cell form.

A homogeneous distribution of the radiation so that no portion of the tumor receives less than its lethal share is a prime requisite for success in radiotherapy. In order to accomplish this end a thorough knowledge of the physical factors concerned is essential. As the surface area to be irradiated increases in dimensions and more radium foci become necessary, each unit area receives correspondingly more radiation from the neighboring radium foci. This factor must be compensated in estimating the dose. Thus, for example, a surface area of 4 square centimeters may require 1.5 millicuries-destroyed (200 milligram-hours) per square centimeter, whereas a surface area 25 sq. cm., on account of the cross-firing effect, should receive approximately 1 millicurie-destroyed (133 mg-hr.) per square centimeter.

Utilizing a miniature ionization chamber constructed by Stahel, Murdoch and Simon of the University of Bruxelles have conducted most elaborate and detailed studies and constructed curves indicating the precise quantity of radiation received by each unit of surface area under treatment. This excellent research constitutes an invaluable aid in effecting uniform irradiation of a surface area with mathematical precision.

The importance of distributing the irradiation over a period of several days has been emphasized. It is equally essential to confine the entire cycle of irradiation within a given interval of time. The existence of an optimum time interval of irradiation has been claimed by the French school (Regaud, Lacassagne, Monod, Coutard). The principle of radio-immunity established by Regaud and Nogier is an established clinical fact. Unless the irradiation is confined to a limited time interval, the tumor develops an immunity to further radiation and fails to respond to subsequent exposures. It is essential to plan the irradiation so as to deliver the entire series within a limited interval. The optimum time interval appears to vary with different lesions and is not yet fully established. For carcinoma of the pharynx and larynx it appears to be approximately two weeks. In the treatment of cancer of the skin and mucous membrane of the tongue, it is approximately five to seven days.

In order to effect a correct irradiation of a cancer of the skin, the following conditions must be fulfilled: The dose must be adequate and uniformly distributed over an optimum interval, yet confined within a limited period. The filtration must be adequate in order to utilize the most penetrating radiation.

The technical application of radium to cancer of the skin is accomplished by fixed plaques or preferably by molded applicators. In the treatment of lesions affecting flat surfaces, plaques are convenient and quite satisfactory. When a curved surface is affected, as for example on the face, the technique of molded applicators as devised and practised in the Curie Institute constitutes the most accurate and satisfactory method. The preparation of plastic molds is time consuming, but the results following this precise technique fully justify the efforts.

THE TREATMENT OF POST-IRRADIATION RECURRENCES

The treatment of cancer of the skin which has been previously irradiated but uncon-

trolled constitutes a serious and difficult phase of the treatment of skin cancer. An accurate estimation of the necessary dose is impossible. The cellular changes induced in the tumor bed and in the skin must be reckoned with and the tumor cells usually incarcerated in dense fibrous connective tissue are much more immune to irradiation than at the initial exposure. Some leading radiotherapeutic clinics refuse to undertake radiation treatment of recurrent carcinoma following previous inadequate radiation therapy. As a rule, surgery or electrocoagulation is preferable to further irradiation in the treatment of these lesions, although in some examples in which the previous irradiation consists of a very small dose, a second irradiation may be undertaken with safety.

In several cases I have succeeded in eradicating post-irradiation recurrences by the insertion of removable platinum radium needles. In one case an open ulcerated recurrence in the skin of the left temporal region of four years' duration treated by repeated inadequate surface radium applications was treated by this method and the patient is now free of disease (eighteen months after treatment).

THE TREATMENT OF CANCER OF THE EYELIDS

Carcinoma affecting the edges of the eyelids constitutes a difficult technical radiotherapeutic problem. I have used plastic molds in the treatment of these lesions. In 3 cases the disease was eradicated and in the fourth a recurrence promptly appeared. The recurrence was treated surgically. As a rule, if the first irradiation fails, surgery or electrocoagulation should be considered as the second procedure.

THE TREATMENT OF ROENTGEN AND RADIUM BURNS

The treatment of roentgen and radium burns constitutes a serious problem in radiotherapy. As a rule, wide surgical excision of the diseased parts followed by reconstructive plastic repair is the method of choice if conditions permit this course.

In some circumstances problems arise in which more conservative measures may be advisable. Cancer of the fingers and hands in radiologists presents a particularly serious problem. Conservative procedures of irradiation and local surgical excisions have proved successful in some cases and disastrous in others. No blanket rules can be stated and each case must be individualized.

In one case an extensive but superficial keratosis of the back of the hand resulting from repeated roentgen exposures responded to surface radium application and there has been no sign of recurrence for two years. In a second case a roentgen burn of the finger caused by a single roentgen exposure was completely eradicated by intense surface radium therapy. Since both these patients are surgeons in active practice, it was gratifying to control these lesions by conservative measures. On the other hand, I have seen disastrous results from overconservatism. These might be avoided by promptly instituting a radical surgical procedure, should the conservative irradiation procedure fail to control the disease.

RADIATION THERAPY OF CANCER OF THE LIP

Carcinoma of the lip, if not too extensive, is amenable to surface radium therapy, and the results, so far as control of the primary lesion is concerned, have been highly satisfactory. The technique has been standardized. A molded applicator is made so as to permit irradiation of the lesion from three surfaces (inner, outer and superior). The radiating surface is measured and the usual dose applied is 0.7 millicuries-destroyed (93 mg-hr.) per square centimeter. The distance is 7 mm. and the filtration is 1.0 mm. of platinum. When the lesion is small and superficial, the irradiation may be short, lasting only two or three hours. Larger lesions are preferably treated over a longer period of time (ten to fifteen hours).

The treatment of the submental and submaxillary lymphatic glands in cases of carcinoma of the lip remains a subject of controversy between those who advise pro-

phylactic radical resection of the regional lymph nodes in all cases of carcinoma of the lip and those who employ radiation therapy. It is not within the scope of this communication to discuss various phases of this controversy. Careful studies upon this question in the Curie Institute have led to the conclusion that intensive irradiation is at least as effective as radical surgical removal in the treatment of the regional lymph gland areas in cancer of the lip. I have adopted this policy in the Tumor Clinic of the Michael Reese Hospital and in the Edward Hines Veterans' Hospital. Berven pursues a similar course in the treatment of these lesions in the Radiumhemmet at Stockholm, and at the Memorial Hospital, New York City, Ewing and Quick have advised and practised conservatism in the treatment of cervical node metastases from primary intraoral lesions.*

* For discussion see page 742.

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SQUAMOUS CELL CARCINOMA OF THE SKIN*

By CHARLES L. MARTIN, E.E., M.D.
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JUST thirty-three years have elapsed since Stenbeck[27] reported the first case of cancer of the skin successfully treated with irradiation alone. His patient was afflicted with a basal cell tumor and a good result was obtained with moderate dosage. The efficacy of radiation therapy for this sort of cutaneous malignancy was rapidly established and the method is generally accepted today. Squamous cell carcinoma, on the other hand, is much more radioresistant and its successful management has been accomplished by only a relatively small number of radiologists who have possessed the courage of their convictions. In spite of their excellent contributions to the literature, the idea has become widespread, especially among dermatologists, that irradiation is of doubtful value in the treatment of prickle cell cancer. This article is written in a effort to show that roentgen rays and radium constitute the therapeutic method of choice for all such tumors except those situated on some cartilaginous structure such as the auricle of the ear.

Carcinoma of the lower lip is one of the commonest of the squamous cell varieties and some of the current opinions relative to the irradiation of this lesion are most interesting. Sutton[28] says, "Surgical interference is particularly applicable in cancer of the lip and despite the fact that Pusey and other expert roentgenologists have successfully attacked the disease in this region with the x-rays, in the majority of instances the patient is far safer in the hands of a competent surgeon than elsewhere." Ormsby[20] chooses to ignore the radiological angle entirely and states, "In all lip cases, especially those involving the mucous membranes and the deeply situated prickle cell type, surgical methods should be employed." Stelwagon[26] seems to be in some doubt about the method when he says, "Its special field of usefulness is, in my opinion, as a supplementary measure to those methods already practised and described above." Hazen,[13] who has used radiation therapy rather extensively in the treatment of basal cell lesions, loses courage in the face of the squamous cell variety and asserts, "I agree with the growing number who feel that deep bipolar fulguration for local lesions is the best form of therapy at our disposal." Andrews[1] seems almost apologetic in mentioning roentgen therapy, for he concludes. "The treatment of squamous cell carcinoma solely by roentgen rays is justifiable only in small circumscribed superficial growths less than one centimeter in depth; in other words, in growths amenable to removal by surgery, diathermy or radium, to all three of which methods roentgen therapy is inferior with the usual apparatus and technic used for dermatological purposes." MacKee[15] in a book dealing exclusively with the use of roentgen rays and radium in dermatology says, "At the present writing the author regards well developed prickle cell epithelioma of the skin or the mucosa a surgical disease and it should receive radical surgical treatment either with the knife or with endothermy."

Such impressive opposition should cause one to be most hesitant about recommending any procedure, but a study of the techniques recommended by these authorities offers a most satisfactory explanation of their lack of enthusiasm. My father, James M. Martin, built his intensive plan of treatment around the original technique of Pusey[21] published twenty-five years ago, and it has been used continuously in our laboratories ever since with most satisfactory results. Although Pusey had no way of

* Read in a Symposium on Cancer of the Skin, Seventeenth Annual Meeting, American Radium Society, New Orleans, La., May 9–10, 1932.

measuring his dosage in the early days, it is evident that he gave many times an erythema dose to each case. Photographs and photomicrographs in his publications show conclusively that he cured patients afflicted with squamous cell carcinoma. In one of his early books he says, "The first aim in giving the exposures should be to produce a moderate x-ray reaction. To this end exposures should be given at intervals of one to three or four days and should be continued until involution of the tumor begins. Only rarely is it necessary to push the exposures to the point of producing a vigorous dermatitis in order to get an involution of the tumor. . . . In cases where there are unusual reasons for haste, as for example with deep rapidly growing epitheliomata, I push the treatment from the start and produce a dermatitis quickly." About fifteen years ago when we installed Coolidge tubes and better generating apparatus we decided that our most satisfactory cases of lip carcinoma were receiving from five to ten erythema doses delivered in a period of eight to fourteen days and we have since seen no reason for changing this technique.

Other radiologists have arrived at similar conclusions as to the value of an intensive technique. Grier[10] developed a plan in 1915 which, according to the Witherbee and Remer method of calculation, delivered about seven erythema doses to the lesion in one exposure. He reported 19 out of a series of 23 carcinomas of the lower lip cured by this technique. In 1922 Bowen[3] published some equally good results obtained by practically the same method augmented by coagulation. Schreiner and Kress[24] using massive doses of somewhat less intensity reported a series of cures in 1924. Recently Dresser and Dumas,[7] who are connected with the Pondville Hospital in Massachusetts, have announced that a lesion not larger than 2.5 cm. in diameter should receive an ulcerative dose (at least five erythemas).

It has been known for a number of years that squamous cell carcinoma of the cervix could be cured only when radium rays sufficient to produce ten to fifteen erythema doses were delivered within the tumor. This knowledge has permeated slowly because of the voluminous German literature describing cures produced with a single erythema dose of deep roentgen rays. Some of these cures, at least, were obtained by augmenting the treatment with radium.

The careful work of Martin and Quimby[17] published in 1930 offers positive proof of the necessity for massive dosage and falls exactly in line with our clinical observations. Their findings caused them to advise that adult squamous cell carcinoma should receive from seven to ten erythema doses of radium rays for an absolute cure.

With these points in mind, an examination of the current ideas about dosage for skin cancer may not be amiss. Wood,[31] after calling attention to the fact that ten to fifteen erythema doses are used in the cure of carcinoma of the cervix and that animal tumors require approximately five erythema doses for their eradication, makes the following rather curious statement: "If an operable squamous cell carcinoma resists two to two and a half erythema doses, as it may, it should be immediately excised as a second heavy treatment may cause severe sloughing of the healthy tissues." Hazen, who advises coagulation as the method of choice, says, "Early prickle cell cancers of the skin can safely be treated with x-rays. The dose should be two to three skin units." Andrews comes somewhat closer to the mark when he states, "Adequate dosage for the treatment of squamous cell epitheliomas with radiation is high. Practically no cures are obtained by less than 2 E.D. and sometimes 5 E.D. are necessary. MacKee who is a strong advocate of surgical methods says, "The technic of application does not materially differ from that described under the heading of basal cell epithelioma." However, he seems to feel the inadequacy of this statement for he adds, "The dose must be large, sufficient to effect a pronounced first degree reaction."

TECHNIQUE

It is our custom to treat all primary squamous cell skin lesions with roentgen radiation alone unless marked induration is felt beneath the tumor or unless the process extends well out onto a mucous membrane as, for instance, at the corner of the mouth. In such cases the treatment is augmented with radium as will be explained later. As stated above, carcinomas lying in close proximity to cartilage are excepted. Before primary lesions are treated they are surrounded by a lead foil shield which allows a border of normal tissue about one-eighth of an inch wide to be exposed. A cone attached to the under side of a tube stand is then brought down so that it exerts firm pressure on the lead shield and covers the diseased area. The factors used are 87 kv. peak, 5 ma., a target skin distance of 10 inches, a filter of 0.5 mm. of aluminum and exposures of 5 minutes. With a Victoreen ionization apparatus placed so as to take back-scattering into account this dose amounts to 555 r with an aperture $\frac{3}{4}$ inch in diameter, 640 r with an aperture of $1\frac{1}{2}$ inches, and 666 r with an aperture of 2 inches. According to the formulae of Witherbee and Remer,[30] which we have found to be roughly correct for our apparatus, our factors should produce an erythema when applied to an area 1 inch square, and such is actually the case. Small lesions receive an erythema dose every second day until five or six treatments have been given. Large, thick tumors are given one or two erythema doses every second day until a total of ten or twelve have been administered. A description of this technique was published by J. M. Martin[18] almost ten years ago.

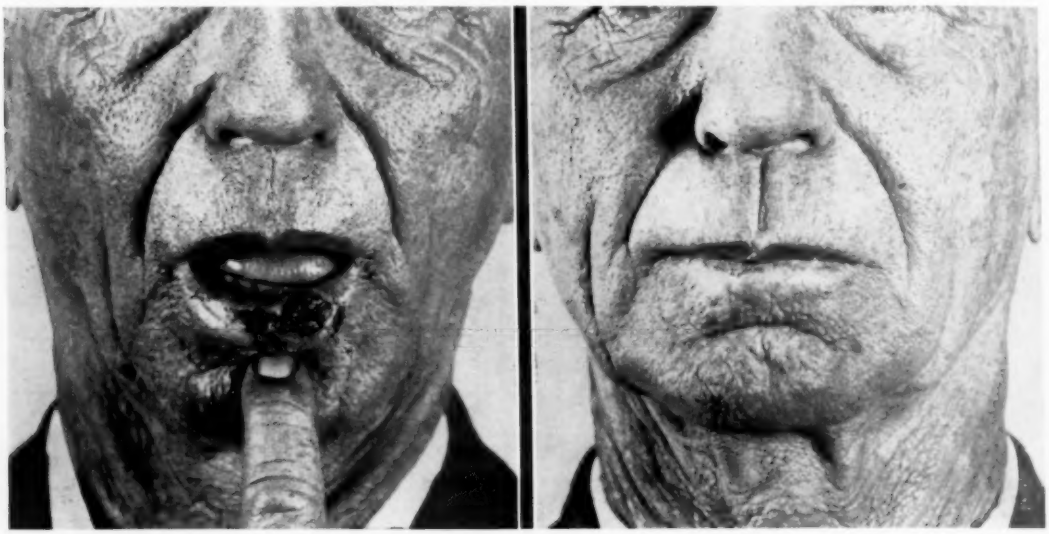

FIG. 1. The crust on this lip covered an ulcer with an indurated base almost 1 inch long. No glands were felt in the neck. In 1923 the lesion was carefully walled off with a lead shield and given a double erythema dose every second day until six such doses were administered, using the low voltage technique. In two months the lip showed a complete restoration of the vermilion border. This patient has remained well for nine years without neck surgery.

As a rule, redness appears by the time the series is finished and the reaction becomes progressively more marked for a period of eight or ten days. The patient complains of some itching and burning but he becomes quite reconciled to this discomfort when he observes that the cancer is melting away, as it almost invariably does during this stage. A seropurulent exudate is thrown off in large quantities and crusts often form rapidly over the lesion.

When the treated area includes the inner surface of the lip, the reaction is quite painful for a week or ten days, but a generous coating of carbolated vaseline and a mild analgesic make the reaction quite bearable. At the end of three or four weeks the malignant tissue has usually all disappeared, leaving a clean granulating wound that heals in fairly rapidly. The entire process for a tumor of average size requires about two months. After becoming familiar with this technique one learns exactly what to expect each week following the cessation of dertreatment. Halfway measures will not produce cures and it is a well-known fact that malignant tumors that are allowed to recur after having been partially destroyed are very resistant to irradiation.

The inner surface of the lower lip may be made accessible to roentgen radiation by everting it, but a tumor of the corner of the mouth often extends out over the inner surface of the cheek so that it cannot be treated by this method. Under such circumstances, small platinum needles of the type recommended by Cade[5] are sewn under the

Fig. 2. Deep induration was felt under this ulcer which measured ¾ inch in width but no glands were palpable in the neck. Six double erythema doses were administered to the lesion and the neck was treated with deep therapy in 1922. The lip was restored to normal in about three months. This patient was examined in 1928, at which time he showed no evidence of a recurrence. No neck surgery was done.

irradiation. If, as sometimes happens with large tumors, the melting down process is observed to slow up or cease before complete resolution has occurred, we do not hesitate to give a second series of treatments and have often turned failure into success by this method. A somewhat smaller dosage is usually needed for the second series and its determination requires some experience. The novice, when he first carries out this technique, will probably spend a few sleepless nights but conservatism has no place in the treatment of squamous cell carcinoma and most of the failures that come under our observation are due to unedges of the lesion in the cheek at 1 centimeter distances and left in place for seven days. These needles each contain 0.6 mg. of radium and the method of using them in the mouth is described in a previous article.[16] During the time that the needles are in place the regular roentgen procedure for the lip lesion is started and carried out as described above. The combined technique has proved very satisfactory.

Williams,[29] in an article published in 1905, commented on the fact that skin cancers beneath which much deep induration could be detected did not respond well to roentgen treatment, and we have also ex-

perienced this difficulty. In such cases a row of weak platinum radium needles planted under the edges of the tumor for seven days augments the superficial irradiation so that excellent results may be obtained. When the induration lies in close proximity to bone as in tumors of the cheek, over the mastoid process, etc., the platinum needles which are heavily filtered may be used in the deep structures without producing a bony necrosis. Cade[6] reports many cures using the needles alone but he also has numerous failures which we believe might have been fewer if he had used the combined technique. Our experience does not include the use of radon implants in this sort of work. Brain,[4] who reports a series of cases in which they were used, feels that they are inferior to external irradiation with radium because of the local necrosis that they produce.

Mention has already been made of the poor results obtained by the intensive roentgen technique if it is applied to lesions situated on a cartilaginous base, and this is particularly true of the ear. However, the small platinum needles may be used in close proximity to the ear without irreparable damage. When a tumor extends into the tissues about the attachment of the auricle to the head a careful needle implantation coupled with a coagulation of the primary lesion has in our hands produced a complete regression of a seemingly hopeless tumor on several occasions.

Tumors of the eyelid are usually of the basal cell variety and for that reason will not be considered in this paper, although they respond to the same general plan of therapy as the other skin carcinomas. However, cancers of the conjunctiva are usually made up of prickle cells and a word about their treatment may not be out of place. In 1924 Grier[11] reported a series of cases treated with an intensive unfiltered roentgen technique somewhat similar to the one described in this paper except that a 7 inch spark gap was employed. Although he states that his dose was a little more than an erythema, his factors, according to the formula of Witherbee and Remer, should produce approximately six times an erythema. Since the areas treated were very small, the effective dose was probably much

FIG. 3. This lesion which was deeply indurated was very stubborn. At the time of treatment no glands were palpable in the neck. Six double erythema doses were administered beginning on July 14, 1921. At the end of three months some evidence of malignancy still remained. Five double erythema doses were then given and the primary tumor slowly disappeared with perfect healing. Eighteen months later small glands were felt beneath the mandible but surgery was refused. Death occurred two and a half years after the first visit. The lip was still smoothly healed at that time.

less than this figure. At any rate his end-results were surprisingly good. Our technique has caused carcinoma of the conjunctiva to disappear in the same manner, leaving practically no scar and producing no impairment of vision. In carrying out this procedure the eye is anesthetized with 4 per cent cocaine and a lead foil shield is carefully prepared with a hole in its center which exactly fits over the tumor on the eyeball. At each visit eyelid retractors are put in place and the shield is put over the eye, often under the lids, so that only the tumor is exposed. Five or six erythema doses are then given, one being administered every second day. The eye is flushed out daily with a saturated boric acid solution and the reaction is surprisingly mild. It is our impression that low voltage roentgen rays are superior to radium rays for this work because only a relatively small amount of the soft radiation reaches the inner layers of the eyeball.

Fig. 4. This large cauliflower tumor was treated in 1919 when our single dose produced a very light erythema. Ten such treatments were administered, one being given every second day. At the end of six weeks a second series was given because the lesion had not completely disappeared. Three months later the lip was practically normal in appearance. This patient has remained well for thirteen years without neck surgery.

TREATMENT OF METASTASES

Since a great deal is written about metastasis from carcinoma of the lip it will be singled out for discussion. Those surgeons who oppose radiation therapy for this lesion, and they are many, have a great deal to say about the necessity of a block dissection of the neck in every case. A close study of their figures reveals the fact that with few exceptions their cures obtained by this method occurred in patients that had only inflammatory nodes or no diseased nodes at all in the neck. As soon as actual malignant disease appears in the lymphatic system good results from radical surgery become exceedingly few. In Sistrunk's[25] carefully prepared statistics only 2 of 11 such patients survived the operation and the five year period. Quick[22] observes that block dissection is not likely to be successful except where only one or two small glands are involved without capsule perforation on one side of the neck, and it is our custom to advise neck surgery for these cases and no others.

To justify such a procedure we must prove that the radical operation does not increase the percentage of cures when the nodes are not invaded. If such be the case,

patients with early lesions should not be subjected to needless mutilating surgery. Duffy's[8] figures are of the greatest interest in this connection. During a seven year period 271 carcinomas of the lip were treated at the Memorial Hospital. No neck dissections were done on the early cases and 90.1 per cent of those entering without malignant adenopathy remained free of the disease. Sistrunk reports 90.3 per cent of five year cures in a similar series in which radical surgery was carried out. The similarity of the two figures strongly indicates that equally good results may be obtained without surgical interference.

Our own experience closely parallels that of the Memorial Hospital. In our series of 218 cases of cancer of the lower lip we have been able to follow 119 for periods varying from five to ten years. Tables covering this study were published in a previous article.[19] Of 108 patients having no glandular involvement at the time of treatment, 104, or 96.3 per cent, have remained well for five years or longer. Only roentgen therapy of the type described above was used in this series. Malignant adenopathy appeared following complete resolution of the primary lesion in 4 cases. It is most unfortunate that one of our well-known surgeons[2] felt impelled to publish a condemnation of radiation therapy after viewing such a patient, losing sight for the moment of the fact that recurrences may also appear after the most radical surgery.

For many years we have administered an erythema dose of copper filtered roentgen rays to each side of the neck in lip cases, increasing the voltage with the advent of new apparatus, but the exact value of this procedure is difficult of estimation. About a year ago Quick's[23] plan for therapy of the neck was adopted because it fits in with our clinical observations. Where no palpable glands are present the neck receives intensive external irradiation but no dissection is done and the patient is kept under careful observation for several years. When glands are found on one side of the neck only, are freely movable, and show no evidence of extension through their capsules, intensive external irradiation is combined with block dissection and sources of radiant energy are buried at suspicious points in the wound. In all other cases, operative removal is dispensed with and external irradiation is combined with multiple buried radioactive sources. Quick advises the latter method in the following conditions:

1. Adult type of epidermoid carcinomas with perforation of the node capsule and infiltration of surrounding structures.

2. Early involvements of transitional cell carcinoma.

Fig. 5. This squamous cell carcinoma started as a papule in front of the ear and passed through the lower portion of the auricle to form a tumor around its lower portion. Small 0.6 mg. platinum radium needles were sewn under the edges of the tumor for seven days. Three 6.25 mg. lead radium capsules with 2.0 mm. walls were laid in the centers of the ulcers for four days. One erythema dose of deep roentgen therapy was applied to the side of the head. The third photograph shows a clean granulating surface at the end of four weeks. The last photograph shows healing almost complete at six weeks. The cartilage is not damaged.

3. Metastatic nodes locally operable but with advanced unfavorable primary growths.

4. Metastatic nodes locally operable but in patients of advanced age or in such general physical condition as to render a complete unilateral dissection unduly hazardous.

5. Nodes operable but bilateral.

6. Recurrent nodes.

In carrying out this plan we have substituted small platinum radium needles for radon seeds and 50 mg. radium blocks for the large trays used at the Memorial Hospital. Regressions of extensive lesions in the neck have been observed, although few of them last more than six to eight months. However, the treatment is much less severe than radical surgery and the results are equally good if not better.

Fig. 6. This was a squamous cell carcinoma surrounded by deep induration which extended down to the periosteum. Long 1.33 mg. platinum radium needles were placed deep under the borders of the tumor for seven days and six erythema doses of roentgen rays were given to the surface in accordance with our standard technique. Healing was rapid and complete as shown in last photograph made two months later.

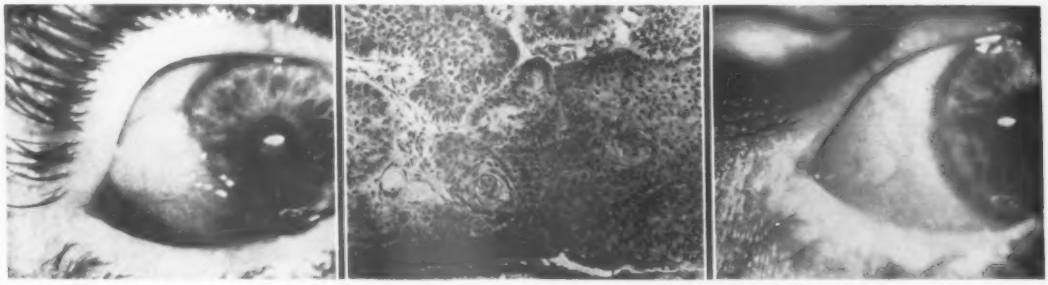

Fig. 7. The photomicrograph shows this large tumor of the conjunctiva to be a squamous cell carcinoma. It had been removed surgically twice but had recurred each time. Five 0.6 mg. platinum radium needles were sewn into the orbital tissues along the drainage area and left in place five days. Six erythema doses of roentgen rays were given to the lesion, one being administered every second day. At each visit the eye was cocainized and a lead shield was fitted snugly around the tumor. In six weeks healing was complete and the vision was not impaired.

ADVANTAGES OF IRRADIATION

Since it has been shown that the patient afflicted with cancer of the skin has just as good a chance of a permanent cure from irradiation as from surgery, a comparison of the relative merits of the two methods is now in order. The roentgen-ray method offers a big economic advantage since hos-

pital costs are eliminated and only a brief period need be lost from the patient's daily routine. Also it should be remembered that operative complications are not encountered. However, the outstanding advantage is the cosmetic result that may be obtained and this applies particularly to cancer of the lip. Operative methods are at best somewhat mutilating if the work is thorough and a block dissection produces a most unsightly appearance. In lesions of average size and even in many that involve more than half the lip the roentgen technique conserves all normal tissue and the vermilion border is usually returned to almost a normal appearance. That similar results may be produced with external radium applications has been demonstrated by Haagensen,[12] Kennedy,[14] Duncan[9] and others, but it has been our observation that results obtained with implantation techniques are more likely to show scarring and deformity. Cade's small needle implantations seem to produce less permanent change than do radon seeds.

CONCLUSIONS

1. The number of cures of squamous cell carcinoma of the skin produced by efficient irradiation equal those produced by surgery and the cosmetic results are much better.

2. The pessimistic attitude that exists among dermatologists is apparently due to overconservatism and inadequate dosage.

3. Surgical methods are valuable adjuncts in treating tumors growing on cartilage and in neck dissections where only one or two malignant glands are present.

4. An intensive roentgen-ray technique augmented by small platinum radium needles for the deeper lesions is described.*

* For discussion see page 742.

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THE TREATMENT OF CUTANEOUS MALIGNANT NEOPLASMS*

(A BRIEF OUTLINE)

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THERE is no certain cure for metastatic cancer after the affection has become invasive, therefore the mortality of cancer is high. It is the aim of the medical profession and especially of those physicians who are particularly interested in the subject, to lessen the incidence and mortality of cancer. At the present moment the best way to accomplish this is to diagnose and completely destroy a malignant growth before it has become invasive and before metastasis has occurred. Such a desirable objective is difficult to attain in the case of internal cancer. It should, however, be possible of attainment in the case of cancer of the skin and orificial mucous membranes. Malignant neoplasms of these structures are common. It is obvious, therefore, that if all or most of the cutaneous cancers were recognized and destroyed while still local, there would be a very substantial diminution in the mortality of the disease. Even more than this can be accomplished. It is possible to recognize and destroy most of the cutaneous conditions that may lead to cancer. The well-trained dermatologist is able to satisfy these requirements, but comparatively few persons seek the advice of a dermatologist for these conditions. Most of them first consult their family medical adviser as they should do. Too often the general physician fails to recognize a dangerous lesion or even to suspect the danger until the disease is beyond control, or he may suspect the true nature of the lesion but apply inadequate treatment. It seems advisable to urge more and better undergraduate and postgraduate medical instruction in this subject. In addition, the various seminars given under the auspices of state and county medical societies, and the programs of the many smaller medical societies, should frequently include illustrated lectures on cutaneous cancer and the cutaneous conditions that are potentially dangerous.

THE SO-CALLED PRECANCEROUS DERMATOSES

It has been said that every cancer is preceded by some detectable lesion. So far as concerns cutaneous malignant neoplasms, the accuracy of this statement is controversial. While many, perhaps most, cutaneous cancers develop in some recognizable antecedent condition, some occur in skin that is clinically normal. It is possible, however, that cancer never develops in absolutely normal skin. There may be an antecedent condition that can be recognized only under the microscope. An analogy that may appeal to the clinician is the so-called nevus tardus—a congenital defect that does not become visible to the naked eye for weeks, months or even years after birth.

Some dermatologists and pathologists object to the term precancerous. They aver that the precancerous dermatoses are either cancer from the start or that they are no more dangerous than is normal skin. I am not in entire accord with this contention. While it must be admitted that many of these conditions seldom give rise to cancer, there are a number that are exceedingly dangerous. For the purposes of conversation and teaching, it is convenient to place these conditions in a group and to give the group a short title. There are logical objections to the term precancerous dermatoses for this group, but until a better title is suggested, it seems preferable to employ the one now in vogue.

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An example of a condition that is not very dangerous but which might give rise to cancer when repeatedly irritated over a period of years is any small permanent elevation above the surface of the skin as, for instance, a small hyperplastic scar. In fact, skin or membrane, originally normal may, after sufficient irritation, become the site of a malignant neoplasm. Many of the precancerous dermatoses fall in this class. They are dangerous simply because they are more likely to be repeatedly traumatized than is the normal skin or mucous membrane. Among the most dangerous cutaneous conditions are leucoplakia, kraurosis vulvae, senile keratoses and the blue-black mole.

Time will not permit a discussion of the entire group. An enumeration and a few pertinent facts concerning the important members of the group will suffice for our purpose.

Leucoplakia. While some clinical types of leucoplakia are relatively benign, the affection on the whole is dangerous. The development of epithelioma is frequent and it is always of the prickle cell variety. Treatment depends upon conditions. Small patches may be destroyed with electrodesiccation, actual cautery or with radium. It is customary to treat extensive patches expectantly and keep the patient under observation. In such cases, any erosion, fissure or warty excrescence that may develop, should be properly destroyed.

Keratoses. There are a variety of keratoses—seborrheic, nevoid and senile, and those caused by arsenic, roentgen rays and radium and solar radiation (sailor's skin). When epithelioma develops in a seborrheic or nevoid keratosis, which is possibly not frequent, it is usually of the basal cell type. The other keratoses are much more dangerous. Not infrequently they give rise to epithelioma, usually of the prickle cell variety. The senile keratosis, when occurring on the mucous membrane of the lip, is especially dangerous. It is customary to destroy potentially dangerous keratoses with electrodesiccation or electrocoagulation, or to remove them by surgical excision. Selected cases are treated with roentgen rays or radium.

Kraurosis vulvae is dangerous principally because of the keratoses and leucoplakia that so often develop.

Nevi. Moles are of various types and they are extremely common. In fact there is hardly a person who has not at least one mole on some part of the body. With the exception of the flat, smooth, blue-black mole and some of the non-hairy, deeply pigmented, elevated nevi, moles are not considered very dangerous unless irritated.

Miscellaneous Conditions. Prickle cell epithelioma occurs occasionally in long-standing cases of lupus vulgaris and lupus erythematosus. It occurs in indolent ulcers, especially in ulcers that develop in the so-called roentgen-ray skin. Either prickle cell epithelioma or sarcoma may develop in large scars.

Bowen's precancerous dermatosis and Paget's disease of the nipple have been removed from the precancerous dermatoses because it is now the consensus of opinion that these and allied conditions are cancer from the beginning.

THE COMMON CUTANEOUS MALIGNANT NEOPLASMS

Epithelioma. The majority of cutaneous cancers are basal cell epitheliomas. When of pure type this variety seldom undergoes metastasis. It is rare for them to develop primarily in the mucous membranes, although these structures often are involved secondarily. It has been estimated that approximately 10 per cent of basal cell epitheliomas contain squamous cells. Such tumors may be metastatic and recalcitrant. The majority of basal cell epitheliomas of pure type are easily cured but some of them are stubborn. Statistics compiled by various authors differ considerably. One may expect about 80 per cent permanent cures in unselected cases with any one of the recognized therapeutic methods when expertly applied. With selected material and selected methods the percentage may be

95. I doubt the possibility of obtaining 100 per cent permanent cures. One might discuss at great length the treatment of basal cell epithelioma, giving detailed indications for lesions of various sizes, depths and locations. This cannot be undertaken here. Briefly, there are lesions that require surgical diathermy, others that demand a combination of surgical diathermy and radium, or roentgen rays. In certain instances scalpel surgery can be employed to advantage, while in others the best results are obtained with radium or roentgen radiation alone. It is essential that the clinical diagnosis be as near unequivocal as possible. If there is the slightest doubt about diagnosis there should be a microscopical examination.

I am aware of the excellent results obtained in selected cases of operable prickle cell epithelioma with radium and with roentgen rays; also the splendid results obtained with these agents in inoperable cases. Nevertheless, it is my opinion that in general, operable metastatic cancer of the skin and orificial mucous membranes should be treated surgically. Surgery includes both scalpel surgery and surgical diathermy. In many cases of operable prickle cell epithelioma, it is advisable to combine surgery with radium or roentgen rays. Whether the tumor should be irradiated previous or subsequent to excision is a matter of opinion and will depend upon many factors such as clinical or pathological type, location, etc. Whenever possible, there should be a microscopical examination. This will determine the grade of malignancy. It will show whether the disease is local or invasive. And in case the lesion is not invasive, a careful study of serial sections made from the excised tumor will determine whether or not all the pathological tissue has been removed. Without microscopical study it is doubtful if one can select the most suitable therapeutic method. It appears to be now the consensus of opinion among cancer experts that a properly performed biopsy does not cause metastasis. Many prefer to remove tissue for microscopical study with the cutting current. This is satisfactory for large pieces of tissue, but small pieces are likely to be so modified by coagulation as to be useless for the purpose.

There is no sharp dividing line between operable and inoperable cancer of the skin. When the lesion is not invasive, when it is probable that metastasis has not occurred, and when it is of suitable size and in a favorable location, I believe that surgical excision is the method of election. For the more advanced case, one must select with discriminating judgment based on careful study, the best therapeutic agent or combination of agents.

Based on pathological characteristics, prickle cell epitheliomas are of four recognized grades of malignancy. Clinical dermatologists recognize several grades of malignancy based on clinical features. When the lesion develops in sclerotic tissue, as in lupus, interstitial glossitis, scars, roentgen-ray skin and in some keratoses and some cases of leucoplakia and kraurosis, evolution is likely to be slow and metastasis delayed. Epithelioma developing in an apparently normal tongue is apt to be rapidly invasive. On the whole, the evolution of prickle cell epithelioma of the skin is not particularly rapid, but occasionally a lesion will appear suddenly in apparently normal skin or membrane, invasion of neighboring tissue is rapid and metastasis occurs very early. Occasionally, epithelioma attacks the skin secondarily from a focus in some other organ. An example of such secondary invasion is cancer en cuirasse.

Sarcoma. Many, if not most, of the morphological types of sarcoma and melanoma are found among the cutaneous malignant neoplasms. A few are rarely encountered elsewhere. Many of them develop in a preexisting condition such as a nevus, scar, etc. Occasionally, sarcoma attacks the skin secondarily from a primary focus in some other organ. Cutaneous sarcomas and melanomas are, of course, of different grades of malignancy. Some are exceedingly malignant while others, as for instance, the Kaposi type, are easily cured or controlled.

While excellent results may be obtained in early, highly malignant cases with radium, it is my opinion that some form of surgery is the method of choice. When excision is possible, I prefer it because one then may profit by all the advantages to be obtained by a careful microscopical study. Radium and roentgen rays are useful for inoperable cases and particularly for lesions of comparatively low malignancy. Roentgen rays are especially useful for the Kaposi type of sarcoma.

RECOGNIZED METHODS OF TREATMENT

In the past, dermatologists and others treated cutaneous cancer with the method with which they were most familiar, regardless of type, size, depth and location of the lesion. Thus, the surgeon always employed the scalpel, the roentgenologist depended solely on roentgen rays, the radium specialists used only radium, the diathermy enthusiast insisted on the use of surgical diathermy and so on. The same statement is true today but to a lesser degree. Statistics show that excellent results may be obtained in properly selected cases with any of these methods when expertly applied. The results are not so good in unselected material. There is no best method for the treatment of unselected cases of cutaneous malignant neoplasms. Any one method or a combination of methods may be the best procedure for an individual case. The physician who has had extensive experience with all the recognized methods of treating malignant neoplasms of the skin and orificial mucous membranes, and who is thoroughly acquainted with the clinical and histological characteristics of such neoplasms and the conditions that may cause them, is in a position to employ discriminating judgment and to obtain the best results. Undoubtedly statistics will improve when every physician who attempts the management of cutaneous cancer possesses this comprehensive ability. Here, too, there is need for more and better postgraduate instruction.

The recognized methods of treating cutaneous malignant neoplasms are scalpel surgery, surgical diathermy, roentgen rays and radium. Lack of time prevents a discussion of scalpel surgery and permits only a few words relative to the other methods.

Roentgen Radiation. Roentgen rays are satisfactory for many basal cell epitheliomas. Small superficial growths may be treated with unfiltered radiation. Moderate or heavy filtration is preferable for very thick or deep-seated lesions. It seems that approximately the same results are obtained by large doses administered at intervals of two or more months or by smaller doses so spaced that an intense effect is obtained in a week or two. It should be emphasized that when a lesion fails to respond favorably to two intensive doses, the treatment should be discontinued. When containing squamous cells, when involving cartilage and other subcutaneous structures, and when composed of hard nodules, basal cell epitheliomas are likely to resist roentgen irradiation. Many basal cell epitheliomas will disappear with hardly a trace as a result of roentgen therapy, but the cosmetic result is often disappointing because of atrophy and telangiectasia caused by the treatment, and scarring caused by the disease.

Heavily filtered roentgen radiation constitutes a valuable adjuvant for the treatment of prickle cell epithelioma. I prefer not to depend on roentgen rays alone for operable cases.

Radium. In general, what has been said relative to roentgen rays may be repeated for radium. Radium is the better of the two agents for unselected cases of metastatic cutaneous cancer. It can be used in locations that are inaccessible to roentgen radiation. There is better opportunity for cross-fire. Radon implants may be used and so on. For selected cases, assuming proper facilities and expertness, the results are probably approximately the same with either agent. It may be interjected that the facilities and skill required for the modern roentgen and radium treatment of unselected cases of inoperable metastatic can-

cer, even of the skin and orificial mucous membranes, are so exacting that they are found in comparatively few medical institutions and private offices.

Surgical Diathermy. The production within the tissue, by means of a high-frequency current, of an amount of heat sufficient for destructive purposes, is known as surgical diathermy. Three forms of surgical diathermy are universally employed. They have been designated electrocoagulation, cutting current, and electrodesiccation. The first two depend on current obtained from various parts of the primary winding of the high-frequency transformer. This coil was formerly called the solenoid and current therefrom was known as the d'Arsonval current. Either of these currents may be bipolar or monopolar, damped or undamped. The current for electrodesiccation is obtained from the secondary of the high frequency transformer. This coil was once known as the resonator and the current therefrom was called the Oudin current. The current is monopolar and its therapeutic application was formerly termed fulguration.

With electrodesiccation it is possible, by surface sparking, to dehydrate or mummify a pinhead-sized superficial area, or a fairly extensive superficial lesion. By multiple insertions of the active needle electrode, one may destroy rather large, thick lesions. The method is employed mostly for the destruction of small, superficial benign growths, potentially dangerous lesions such as leucoplakia, keratoses, etc., and small superficial epitheliomas of the basal cell type. It is being abused by many physicians who employ it mistakenly for electrocoagulation and who use it without any form of anesthesia.

The current for electrodesiccation has an exceedingly high voltage and a comparatively low milliamperage. That for electrocoagulation has a lower voltage but a higher milliamperage. The cutting current has still lower voltage and higher milliamperage.

The electrocoagulating current, when used as a surface spark, dehydrates to some extent, but the principal effect is that of rather widespread coagulation of tissue, especially when the active needle electrode is inserted into the tissue as is usually done. The gross change may be no more than a blanching or whitening of the tissue which later sloughs. Electrocoagulation seals the blood vessels and lymphatic vessels. It is used mostly for the destruction of malignant neoplasms. It is customary to first establish a line of deep coagulation beyond the periphery of the lesion, the entire lesion is then coagulated and removed with the cutting current, scalpel or curette, after which the wound may be electrodesiccated or superficially electrocoagulated. Coagulation can be performed with the bipolar current using either a single or bipolar active needle electrode or with monopolar current from the same general source.

The cutting current cuts like a knife and causes enough coagulation to seal the small blood vessels and lymphatic channels. Theoretically, at least, there is less chance of metastasis during the application of surgical diathermy than with the scalpel or curette. Excision with the cutting current is comparatively bloodless. It is possible to obtain primary union, especially if the edges of the wound are freshened with the scalpel or scissors.

Surgical diathermy can be employed satisfactorily when scalpel surgery would be difficult or impossible. When using high-frequency currents for destructive purposes, one is likely to think in terms of physical therapy rather than in terms of surgery, which may lead to careless technique from a surgical standpoint. Surgical diathermy is surgery and to it should be applied the principles of general surgery.

DISCUSSION OF SYMPOSIUM ON CANCER OF THE SKIN

DR. LESTER HOLLANDER, Pittsburgh, Pa. The American Radium Society is exceptionally fortunate in having Dr. MacKee present his views on the subject of cancer of the skin. As

you know his book "X-Rays and Radium in the Treatment of Diseases of the Skin," is the authoritative one and the technique described therein is used by most of the American dermatologists.

As in this discussion radium is of secondary importance, I want to emphasize a few points in regard to cancer of the skin.

The question of diagnosis is of prime importance, and although it is not difficult, it is missed at times by forgetting the cardinal signs of cancer of the skin, among which slow progression, lack of pain, unusual hardness (plaster-of-Paris hardness) stand out prominently. Syphilis, tuberculosis, nevi and deep mycelial infection should always be thought of and eliminated before a diagnosis is established. The engrafting of carcinoma on skin tuberculosis, especially of the lupus vulgaris variety, and on tertiary syphilitic lesions of the tongue is familiar to all of you; I raise these points merely to state that treatment of carcinoma in these instances must be altered accordingly and also to caution you against the use of arsenicals in the latter instance.

Another point of importance from the standpoint of treatment is the location of the cancer. Dr. MacKee stressed this point. The abstract of Dr. Taussig's paper as it appears on the program also pays particular attention to location as a guide in therapy. I use the electrical cutting current in cancer of ears, nose, eyelids, external genitalia and extremities.

In carcinoma of the cheek and neck I prefer the use of roentgen rays in massive doses of four units and up, as advocated and taught by Dr. MacKee. For keratosis senilis roentgen radiation in one or two unit doses is utilized, yielding excellent cosmetic and therapeutic results.

The only comment I want to make on Dr. Martin's presentation is that well-managed radiotherapy is preferable to indifferent surgery in carcinoma of the lip. It is my practice for this type of carcinoma to carry out the following procedure: (1) taking care of the oral sepsis; (2) the use of interstitial implantation of radium emanation; (3) block dissection of the glands of the neck, and (4) intensive deep roentgen therapy as a follow-up to the region of the cervical lymph nodes.

The last point which I want to make is concerning precancerous and cancerous lesions of the female external genitalia, which include kraurosis vulvae, leucoplakia and chronic ulcers associated with pruritus vulvae. My experience has been most unsatisfactory with irradiation and it is my belief that vulvectomy, followed by a bilateral inguinal lymph node dissection, this latter only in the presence of carcinoma, is the method of choice and offers relief and better assurance of cure.

DR. WILLIAM H. CAMERON, New York City. Regarding the treatment of basal cell epitheliomas. Judging by the papers presented, we must conclude that the results from recognized methods are about equal. Why is this possible? Because most early basal cell lesions can be cured by any method that removes or kills all diseased cells. If we use radium rays, and the radiation is homogeneous, we will cure a majority of the cases and there is less deformity. Whether we use small radium units for a long period of time or larger amounts for shorter periods is of no greater moment when the lesion is very radiosensitive. Basal cell lesions are, however, more complex than most of us imagine and it is not uncommon to encounter lesions (usually situated on external ear and at the ala nasi) that do not respond to any radiation dose short of caustic destruction. Until we know more about the pathology of such lesions, I believe irradiation should be followed by surgery when it is found that the lesion is not responding well to ordinary radiation doses.

The treatment of squamous cell epitheliomas is a complicated proposition. All cases should be individualized and tested for their possible radiation susceptibility. In my opinion, surgery is no longer justifiable in radiation susceptible lesions of this type—that is, of course, when the lesion can be reached.

On the question of glands: I have been using large doses of hard gamma rays from a 2 gram element pack and am convinced of the effectiveness of this form of treatment and, when there is no question about the glands being involved, I believe it offers more in the way of palliation.

DR. LEROY SANTE, St. Louis, Mo. It has been our dictum in the treatment of epithelial lesions to proceed according to the following plan: We never consider any lesion, no matter how large, as absolutely hopeless until it has been given the test of radiation. That is, one full, tolerance dose is applied to the involved area, and it is then observed for any indication of regression. If there is any evidence of regression intensive irradiation is proceeded with. In the case of readily accessible surface lesions, we can block off the surrounding tissue with lead and admin-

ister continuous and repeated radiation to the growth itself. Why stop at seven erythema doses of irradiation, or ten or even fifteen? If the growth is on the surface you cannot do any damage. Use the tumor mass itself as a filter and treat for its base. I am speaking of the primary growth, metastatic lymph gland involvement has the intact skin over it.

Dr. Cutler's work is very interesting, particularly in regard to the use of radon around the cartilage of the ear. We have been very careful about such cases since ulceration of the cartilage is very intractable. I think there is a general tendency where the growth is thick to use interstitial radiation at the base, and in our experience there is not much difference between the radon seeds and radium element needle.

Dr. Martin presents statistics that cannot be easily discounted. When he can produce such statistics they must be given consideration. It is by statistics such as these extending over a period of years, that the best methods of treatment will be arrived at. I think any method that shows 90 to 96 per cent cures must be considered as a very effective method. This is a much greater percentage of cures than most other diseases with which we have to deal.

I think glandular metastasis is the real problem for radiologists. Why the same cell that produces a cancer of the lip when it gets into the structure of the glands of the neck is so resistant is difficult to understand. I think the nutrition of the cell has a great deal to do with it. I believe there are three things to be considered in the effect of radiation on cell structure: (1) the direct effect on the sensitivity of the cell; (2) the effect upon the blood vessels going to nourish the tumor, and (3) the effect upon the nutrition afforded by the environment or bed in which the tumor lies. When the same cells of the carcinoma of the lip get into the glands of the neck the nutrition is maintained by the lymph in which the cell lies, so with the cancer cell in this position we must depend upon the action of the radiation upon the sensitivity of the cell itself. So I think this is the great problem in radiation therapy today. I believe that only a very small percentage of neck metastases can be cured with deep roentgen therapy or the radium pack alone. The interstitial method of irradiation is the only one that holds any great hope in this field.

Dr. MacKee's paper I think is very valuable. I believe it has been the tendency of dermatologists to give smaller dosage. There may be one reason why he feels that the primary lesion should be removed by surgery, and that is because the low penetrating rays used generally by dermatologists will not reach the tumor. It may be that with more penetrating radiation their results will be better.

DR. J. T. MURPHY, Toledo, Ohio. I wish to second what Dr. Martin said about roentgen rays in carcinoma of the lip. I have been using it for about fifteen years with very satisfactory results. My statistics are about the same as his. Our dosage varies from 4,400 to 6,000 r. This is given in two sittings, forty-eight hours apart. I think we should stop using fractional doses in squamous cell epithelioma. The factors are 140,000 volts, 10 inch distance, 5 ma. and no filter. This dose takes with our machine anywhere from twenty-two to thirty minutes. With such doses one must protect the surrounding tissues. For this we use lead cut to suitable size and covering all the parts, except for a small area about the involved tissue. I think we should consider roentgen radiation in this way as a cautery, and the best cautery, because there is no sharp limitation. It is limited only by the depth of penetration of the ray. The central ray should be directed toward the lymphatic drainage of the lip and you will get direct irradiation along the lymphatics in the way the carcinoma will metastasize. The cases I have trouble with in cancer of the lip are the ones that have been through the hands of dermatologists and the patients have had repeated irradiation but with insufficient doses.

DR. HENRY K. PANCOAST, Philadelphia. We must remember that the same principles apply to cancer of the skin as to cancer of the mouth. The exact dosage required must be determined by biopsy and then given.

I would like to have Dr. Cutler answer one question. In many patients with carcinomas treated repeatedly, the growths disappear superficially but infiltrate deeper and deeper and finally below the temporal fascia. We know that the deep tissues are infiltrated even though the growths have not as yet broken through to the surface. I would like to ask what is the best form of treatment for such cases at this stage.

We should not forget to call in the neurosurgeon for the relief of pain in cancer. A patient with great pain in the tongue and radiating along nerve branches in the neighborhood, may receive great relief from an alcoholic injection if the growth has not passed far beyond the midline.

Dr. O. L. Norsworthy, San Antonio, Texas. Special mention was made of treating cancer of the tongue with small amounts of radium in platinum needles with reference to after pain. My experience with cancer of the tongue has been disappointing with any form of imbedded radium so far as after pain is concerned. I have found nothing to give prolonged relief other than alcohol injection of the nerve, and I will ask Dr. Cutler, in closing, how he prevents after pain.

Dr. Maurice Lenz, New York City. At the Montefiore Hospital we have a case of subungual melanocarcinoma of the third left finger which we treated with large doses of high voltage roentgen rays two and one-half years ago for rapidly growing metastatic masses in the glands of the left supra- and infraclavicular regions. At present there is no evidence of active disease. I therefore believe that if no other method, such as removal by the knife or destruction by heat is applicable, a trial with intensive roentgen therapy is justified.

Dr. Cutler (closing). In reply to Dr. Pancoast's question, the lesion shown in the first lantern slide which had failed to respond to repeated surface irradiation and is apparently cured after radium implantation was not deeply situated. It was confined to the skin and subcutaneous tissues.

The question has been asked about pain following interstitial radiation of carcinoma of the tongue and the method of preventing and controlling it. I cannot recall a single example in which this symptom has been a complicating feature, and I am inclined to believe that pain is a prominent feature only when necrosis and sloughing of tissue follows an incorrect irradiation. This condition obtains usually when the filtration is inadequate and the dose delivered to each unit area either too great or delivered over too short a time interval.

Dr. Martin (closing). Please allow me in closing to emphasize the fact that I do not consider four erythema doses sufficient for the eradication of squamous cell carcinoma of the skin. My experience parallels that of Dr. Murphy in that we frequently see patients treated by dermatologists over rather long periods of time with insufficient doses. As you know, such therapy makes it difficult to obtain good results at a later date, even though large doses are given. I hope our dermatological confrères will see fit to modify the techniques which now appear in most of their literature.

Someone advocated high voltage as preferable in the treatment of skin cancer. I believe the voltage makes little difference so long as the dosage is adequate. Pusey's work was done with a low voltage and some of my father's most satisfactory early results were obtained with a 3 inch parallel spark gap.

We have had a case similar to the one mentioned by Dr. Pancoast. A large carcinoma of the inside of the cheek had perforated through to the outside and a gland about 1 inch in diameter was felt below the angle of the jaw. A cartwheel pattern of long low strength platinum radium needles was placed in the cheek and a row of similar long needles was inserted below the mandible and left in place for seven days in accordance with Cade's technique. Rapid improvement occurred and at the end of four months the cheek was healed both inside and outside. Although we feel that this patient is not cured, the palliation is worth while.

Dr. MacKee (closing). The criticism directed at dermatologists is partly justified. But the same criticism may be used against the roentgenologist, the radiologist and, in fact most specialists. In a broad sense the dermatologist is not a cancer specialist or cancer expert. This statement applies equally as well to the average roentgenologist, radiologist, and other contemporaneous specialists. However, the well-trained dermatologist of experience can diagnose cutaneous cancer and he knows exactly how to treat it.

Statistics are useful, but they may be misleading. Men who are really cancer experts can show 85 or 90 per cent permanent cures for unselected cases of basal cell epithelioma and about the same for selected cases of prickle cell epithelioma of the skin and orificial mucous membranes. These results may be obtained with any of the recognized methods of treatment. The statistics for unselected metastatic cutaneous cancer are very much lower. It is probable that these statistics will improve when every physician who treats cutaneous cancer is equally skillful with all recognized therapeutic methods, and when therapeutic judgment is based on a microscopic study of the lesion, in addition to a consideration of location, extent of involvement and many other factors that require training and experience for indiscriminate judgment.

The dermatologist is especially interested in the prevention of cancer. This necessitates the ability to make a clinical diagnosis of early le-

sions and of conditions that may lead to cancer. The dermatologist can do this better than any other specialist. Also, as I stated before, the properly trained dermatologist knows how to treat these lesions. The statement has been made at this meeting that dermatologists give doses of roentgen rays that are too small. The dermatologist uses doses of roentgen rays, when treating cutaneous cancer, which range from two to eight erythema doses, depending on the circumference, depth and thickness of the lesion and whether roentgen rays alone are employed or are combined with some other method. The size of this dose also depends on whether or not a filter is used and, of course, the filtering material and its thickness.

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ROENTGEN TREATMENT OVER VEGETATIVE NERVE CENTERS OR GANGLIA IN DISEASES PRESENTING SYMPTOMS OF DISTURBANCES OF THE VEGETATIVE NERVOUS SYSTEM

BASED ON A STUDY EXTENDING OVER A PERIOD OF FIVE YEARS

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HOW VITAL a rôle does the sympathetic system play and are we ever justified in tampering with it? asked Ranson[37] recently in a discussion of the surgical interference of the sympathetic ganglia or nerves. The roentgen therapist has not given very much thought to this question, but it is confidently believed that roentgen therapy can help to solve many biological questions by concentrating its efforts and study upon the important rôle the vegetative nervous system plays in the human and animal body. In 1927 I published an article on roentgen rays and the autonomic nervous system,[23] with the hope that it might prove an incentive to others to work along the same line. Very little response has come from American roentgen therapists, yet surgery has made its contributions and has reported encouraging results.

The purpose of this article is to demonstrate that roentgen or radium therapy may be used advantageously in certain diseases and that surgery of the vegetative nerves or ganglia should be employed only as a last resort when this therapy fails; and furthermore to show possibilities of development of roentgen therapy in a field which has not received from the radiologist the attention it deserves.

When I began this research on the vegetative nervous system in 1921, only a few had expressed the opinion that roentgen rays or radium might have a positive effect on the vegetative nerves. The general conception was that nerve tissues are highly radioresistant.

The few who tried to produce an irradiation effect on the vegetative nervous system were busying themselves with theories. I succeeded, in 1923, in proving, on the carefully isolated vagus or sympathicus in animal experiment, that roentgen radiation, the same dose as is used on the patient, affects the vegetative nerves, first, with a slight stimulation (Stage 1), which passes then to a paralyzing effect of the treated nerve (Stage 2). Since that time others have found, through following my technique in similar experiments on animals, that these observations are correct. Zimmern and Chailley-Bert,[52] for instance, treating the isolated vagus with 1,500 R, found a considerable diminution of its excitability tested with the "chariot" of DuBois-Reymond. Gabriel[9] found typical changes in the recording electrocardiogram, treating the region of the neck of rabbits, centering a small beam of roentgen rays over the vagus and sympathicus. His electrocardiograms show disturbances in the vegetative nervous system after the roentgen application and a demonstrable increase in the vagus tonus. But I must agree with Zimmern and Chailley-Bert,[52] that these experiments on the non-operated animal never prove satisfactorily just how the influence of the rays can be explained. Is it the vagus, the sympathicus, the thyroid, the parathyroid, or the blood which produces the change in the recording electrocardiogram when the region of the sympathicus and vagus on a rabbit's neck is treated?

Already Swan[45] had, like Gabriel, used this kind of technique, and had come to the conclusion that small doses of roentgen rays render the vegetative nervous system more sensitive, whereas depression might be produced by large doses. For the re-

duction of the biological test to the simplest experiment on the classical nerve-muscle preparations of a frog, the work of Lazarus-Barlow and Dunbar[25] and the very fine experiments of Redfield, Redfield and Forbes[38] must be mentioned. Their conclusion was that radiation (radium) may produce a real increase in the excitability of the nerve, which is small and transient at best, and is followed by a lowered excitability or a block in conduction.

With the positive knowledge derived from animal experiment and clinical observation on patients treated with roentgen rays, I first began—tentatively seven years ago, but more and more systematically during the last five years—to influence the disturbed vegetative nervous system with roentgen radiation in patients who showed typical symptoms of hyperexcitation in certain diseases which will be discussed in the course of this paper. The roentgen radiation was applied either directly to the autonomic nerve center in the diencephalon or to other autonomic centers. All the cases have been treated with short wave therapy from 185 to 200 kv., 0.5 mm. copper, 3 mm. aluminum, 35 cm. skin target distance, wave length 0.166 Å, 4 ma.

Although my material is not great, the results so far have been encouraging, and will improve when we have learned by clinical study to separate the cases that will be benefited by this technique from those that will not respond to roentgen or radium irradiation.

The greatest difficulty to be overcome lies in the fact that a pathological vegetative nervous system does not react as a normal one in animal or human being. We know that physiological or pharmacological reaction can be found reversed when the vegetative system is in a pathological condition, and we must be careful in attempting to make any deductions of a clinical nature from roentgen treatment of the normal system.

There are some *skin diseases* in which the vegetative nervous system shows symptoms of overirritability; the question as to whether it is primarily or secondarily irritated has to be left to the skin specialist for discussion. *Iching, trophic changes of the skin, certain edemata, trans- or exudation of the skin* are symptoms of vegetative nervous disturbances. It is to be expected, therefore, that we shall find many publications in roentgen literature dealing with treatments empirically arrived at for influencing the above-described symptoms. The cessation of itching, for instance, through direct treatment of skin diseases with ultraviolet radiation, roentgen rays or radium, is explained by the paralyzing effect on the end fiber of the vegetative nervous system in the diseased area treated. It is more interesting for the student of this subject to find reports of indirect treatment in skin diseases.

In 1913, Zimmern stated that he cured *pruritus* by irradiating the lower lumbar region. Shortly after that he found that *lichen planus* could be favorably influenced by irradiating the cervical or dorsal ganglia. He called his technique the "radiothérapie radiculaire" to distinguish it from Gouin and Bienvenue's[10] treatment. They treated, with unfiltered rays, the skin above the diseased part which corresponds to the area in which the nerves pass down to the afflicted part of the body. The interscapular skin region, for instance, was treated. Both report interesting results. Gouin and Bienvenue, treating lichen planus, report that the patient reacts with an increased itching the first night, and in two or three days after treatment the itching completely stops and the lichen papules gradually fade. Pautrier,[30] using Zimmern's technique and treating with relatively hard rays, (5 mm. aluminum, 200 R each field), and directing his rays to the paravertebral ganglia and medulla, reports on 35 cases of lichen planus. In 13 cases, after one treatment, the time of disappearance of the disease was from a few days in some cases to three months in others. In 3 cases the itching stopped the same night. In 9 cases, the dosage had to be repeated from three to six weeks after the first application.

Two-thirds of all cases were completely cured and no bad effects were observed. Fuhs and Konrad[8] report, with a few exceptions, only failure, but I believe that the unfavorable results lie in their technique, as only from 100 r to 200 r with 130 kv. was used in their treatment.

Driver[6] also comes to the conclusion that the filtered paravertebral technique of Pautrier and Hufschmidt gives better results than Gouin and Bienvenue's unfiltered skin area treatment. He states that out of 17 cases, 70.6 per cent were favorably influenced; of these, 59 per cent show complete cure. I believe that Driver's results could still be improved upon if he would use deep therapy technique, higher voltage, and harder filter.

The few cases of lichen planus received in our department were treated paravertebrally over the ganglia corresponding to the affected part of the skin, and 250 r was given over each field. The duration of disease was, in most of the cases, of over two years' standing, and the cases were referred to us by our skin specialist after pathological diagnosis was made. The itching ceased in from two to four days after treatment and the end-results were satisfactory.

It was of greater interest to see how certain forms of *eczema* which showed all the signs of vegetative nervous system disturbance (neurodermatitis) could be influenced by paravertebral treatment. We were mostly guided by the symmetrical appearance of the skin eruptions and only cases which showed no improvement or only temporary relief, under local radiation treatment and medication by efficient skin specialists, were treated. No other local or internal remedies were used during the time of treatment and observation.

Case 1. J. McG., motorman, aged sixty-four; referred by Dr. K. Had suffered from eczema on both legs for twenty-four years. He had consulted many skin specialists and received many different kinds of treatment (roentgen-ray, light, and medication) with only temporary relief. The skin of both lower legs was bluish-red, thickened, partly cracked, and extremely itchy. The diseased skin started symmetrically below the patellar region and stopped near the end phalanges of the feet. (Figures 1, 2, and 3 show the skin condition clearly.)

Fig. 1. Case 1. Patient's condition before treatment.

On June 27, 1928, the patient was given two fields paravertebrally over the lower lumbar sacral region. The result was striking. Itching ceased, the bluish-purple discoloration had now changed to a slightly red appearance.

Because we did not appreciate the well-known fact that a skin which has been for such a long time in a pathological condition must be allowed from six to eight weeks to regenerate and become quite normal, we gave a hasty second treatment ten days after the first application (200 r each field) over the area previously treated and two fields (250 r, each paravertebrally) over the upper lumbar and twelfth dorsal region (Fig. 4).

Fig. 2. Case 1. Twenty-four hours after roentgen treatment over the lower lumbosacral region.

We believe today that the first application would have been sufficient. The patient was in excellent condition until November 19, 1931, when he returned with a small recurrence over the instep where previously no eczema had been present. The rest of the skin showed no eczema but marked brownish pigmentation. A repeated roentgen treatment, 400 r each field, paravertebral lumbosacral region, made the small recurrence disappear again.

Case II. M. V. K., physician, aged fifty-eight; referred by Dr. C. Eczema started symmetrically in the scalp behind both ears and in both axillary regions. Different ointments were used, but, except that the itching subsided slightly, the eczema remained stationary for three months. It then increased and spread to the legs, again symmetrically. The affected skin would first start to itch, and would later become inflamed and cracked. Under local roentgen treatment by the skin specialist the inflammation partially subsided but the itching continued.

When he came to our department, practically the whole body, including the face, showed a purplish-red discoloration. The legs seemed to be the worst. The skin was partly cracked, showed scratch marks and was badly inflamed and itchy.

The patient received 250 r (each field), four fields paravertebrally over the lumbosacral region (Fig. 4). The patient slept that night for the first time in many weeks and the redness of the skin and the itching after twenty-four hours was partly diminished, not only in the lower part of the body but also in the face (reflex action).

He reported back a month later because the itching had started again in the upper part of the body. Two fields were given over both sides of the neck, including the diencephalon (Figs. 5 and 6). The reaction was as follows: The neck on both sides was slightly swollen and the itch-

Fig. 3. Case 1. Fifty-two hours later. A pale skin appeared.

ing was worse for forty-eight hours. After that time, the patient noticed a change, the rash and the inflammation disappeared and thereafter the condition improved from day to day. The skin is now normal in appearance and the patient is in good condition.

Case III. Mrs. J. M. H., aged fifty-five. This case is of interest as a symmetrical eczema (Fig. 7) on both hands which existed over quite a time. In addition the patient complained of marked hot flashes. The roentgen treatment in

Fig. 4.

this case over the cervical ganglia, including the centrum of the vegetative nervous system (Figs. 5 and 6) was indicated for two reasons: (1) symmetrical eczema, (2) hot flashes.

The patient received 350 r in two days over both sides of the neck. Fourteen days later the eczema had subsided (Fig. 8). But hot flashes were still markedly present and 200 r over both sides of the neck including the pituitary region was given again. One month later the patient still complained of hot flashes and 300 r over each side of the neck was repeated. After this the hot flashes gradually subsided and the pa-

Fig. 5.

Fig. 6.

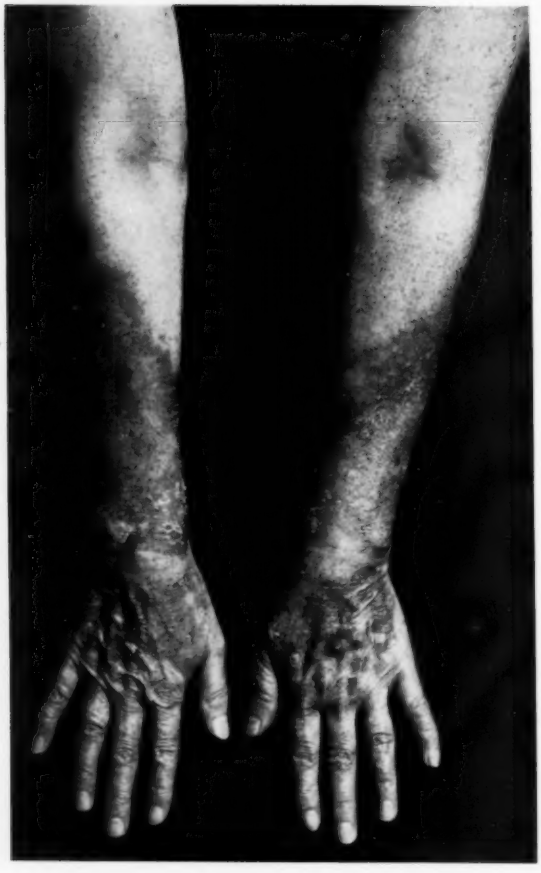

Fig. 7. Case III.

tient is free from eczema and has had very few hot flashes in the last six months.

Of 14 cases of eczema which probably belonged to the neurodermatitis group, 10 improved after one series of roentgen irradiation and 4 had to be treated later on, locally, to obtain the desired result.

The treatment of neurodermatitis with the indirect method has been used by some French dermatologists. Gouin and Bienvenue[10] report 150 cases. Their unfiltered technique aims to influence the end-fibers of the vegetative nervous system in the skin, and they believe in an irritation of the "sympathicus" produced by roentgen radiation—a mistake which so many radiologists make because the study of the roentgen effects on the vegetative nervous system has been so neglected. I must agree with Gouin and Bienvenue that the roentgen treatment can be used as a diagnostic test for finding how important a rôle the vegetative nervous system plays in a certain disease, not only in skin diseases but also in other diseases, as we shall see later.

We observe in all selected skin diseases, treated with the idea of influencing the corresponding ganglia with highly filtered roentgen rays, the following phenomena: A few hours after roentgen treatment the patient complains of fatigue, slight nausea, restlessness, increased perspiration, and eventually the diseased skin itches more than before (Stage 1). This stage might persist for a few hours for four or five days, then Stage 2 sets in, and the itching gradually subsides; the color of the skin changes to a more normal appearance and gradually becomes normal. If the dosage was not sufficient, a second or third treatment should be given with a five weeks' interval. Sometimes a higher situated, overirritated ganglion must be treated before the desired

Fig. 8. Case III.

result can be observed. We do not continue the treatment if no reaction from the vegetative nervous system is observed after roentgen treatment, as this is my test to see if I was mistaken in assuming that the vegetative nervous system is playing a certain rôle in the disease present.

ASTHMA

The medical profession is still at a loss as to how they may benefit some of their asthma patients. Asthma attacks can arise from different causes—disease of nose or throat, emphysema, tumor, neurasthenia (the "psychogenic asthma" of Freud), hypersensitiveness due to allergins, climatic allergins (Storm van Leeuwen),[43] and in practically all the cases a pathological vegetative nervous system can be found. This type of patient who shows so many signs of irritability in his vegetative nervous system such as *fatigue, vomiting, diarrhea or constipation, vasomotor disturbances, irritation of bladder without cystoscopic findings, negative urine analysis*, etc., is often wrongly classed as neurasthenic. It is not surprising that this disease should have been subjected to roentgen treatment and reports of improvement of symptoms after roentgen exposure have been made since 1906 (Schilling).[40] Since that time, hundreds of publications have appeared and practically all types of asthma patients have been treated with roentgen radiation. The roentgenologic literature is singularly negligent in omitting to mention the type of asthma treated and this is one reason why most internists are so skeptical about this form of treatment. The other reason for this skepticism is that different parts of the body were subjected to roentgen exposure and different explanations for the apparent results are offered, depending upon the part of the body treated. The medical profession therefore is justified in raising the question as to whether this is not an influence of the psyche (suggestive influence), as any shock might prevent further asthmatic attacks.

Groedel[11] treats the spleen with roentgen radiation and reports excellent results in a great number of cases. Roentgenologists are interested in his statement that the best results should be expected in cases which react with heavy roentgen sickness. Groedel believes that an irritating dosage applied to the spleen (he gives practically a full erythema dose and repeats the dosage after six weeks) produces antibodies which subsequently influence the asthmatic attacks. Klewitz[19,20] treated 85 patients, using a large field over the chest and four small fields from the back over the lung roots, and he reports 75 per cent improvement; 30 per cent can be called cured as no attacks after treatment were observed (five years' observation). Zipperlen[55] reports from 54 asthma cases treated, following Klewitz' technique but giving one additional field over the spleen (Groedel), 83.5

Fig. 9.

per cent improvement with 27.7 per cent cure. Neither one gives any explanation of the roentgen effect. Ascoli and Fagiuoli[2] treat the hypophysis. They try to explain the greatly reduced asthmatic attacks as due to the influence of roentgen radiation on the glands of internal secretion. Huet and Sobel[17] treat the lower cervical and first dorsal region over the neck and interscapular space and two fields parasternally. They question if the roentgen ray might not have some influence on the "sympathicus." Podkaminsky[33] treats the brain from the occipital region and gives exposures over two other fields behind the ear. His observation time is unfortunately very short, but his reported results so far are excellent. He tries to explain the roentgen effect, but is uncertain if it is the effect on the vegetative nervous system, in the treated skin area.

The only explanation of the results obtained when so different a part of the body is treated is, in my opinion, that a part of the overirritated vegetative nervous system is in all cases quieted down through roentgen treatment. The whole system is then brought through reflex action into equilibrium. Groedel obtained his best results, as mentioned before, when the roentgen sickness was very marked. The effect on the mesenteric ganglia in patients with such overirritated vegetative nervous systems is too obvious. Anyone who has had experience with roentgen treatment in asthmatics must agree that the effect is different from the foreign protein-therapy effect which also influences the vegetative nervous system.

We have treated only asthma patients who had gone through a very careful medical examination and in whom all the known causes that might mechanically or chemically produce an attack were eliminated. Only when all other procedures had failed did we undertake to treat our patients with roentgen irradiation. Our technique is primarily for the purpose of influencing the overirritated vegetative nervous center in the diencephalon. We give exposures through two fields over the neck including the temporal region. The size of the fields is 7×16 cm. (Figs. 5 and 6). In this way the centrum of the diencephalon and vagus and sympathicus of the neck are influenced at the same time, 250 r each field being given. One occipital field is irradiated the next day aiming at the base of the third ventricle and at the same time influencing the vagus and sympathicus again (Fig. 9). If the patient shows marked peribronchial swelling, I give two more fields paravertebrally each from the second to the seventh dorsal, but have found in most of the cases that this is not necessary. The treatment was repeated when the attacks appeared again or when the attacks increased in frequency. We have treated 26 cases during the last five years. Eighty-five per cent responded with distinct diminution of attacks. Many did not have an attack at all for more than two to three years. In cases where ovaries or other glands of internal secretion give rise to overstimulation of the vegetative nervous system an effort should again be made to correct this condition by medication or other forms of therapy. In applying our roentgen technique we think that we may be influencing not the vagus but an overirritated sympathicus. This, however, is absolutely contrary to current teaching, as is also surgical sympathectomy in asthma (Kuntz).[21] Surgical interference should only be tried in asthma cases when repeated roentgen treatment fails, as too many failures with ganglionectomy are still reported.

MENOPAUSE SYMPTOMS

The suggestion of treating the vegetative nervous center in the diencephalon with roentgen radiation, in cases in which such an application might be of distinct value, might create a certain doubtful attitude about its eventual danger for the patient. I have personally never seen any bad effects after such treatment, except that, after repeated roentgen dosage the hair over the treated part fell out, but came back normally in time. Roentgen literature

(mostly German and Italian) gives us examples of cases treated over the hypophysis for menopause symptoms, but does not report any bad effect. It is astonishing how quickly a theory is erected upon an empirically found result after roentgen treatment. Frankel and Geller[7] found in irradiating the hypophysis of young rabbits an underdevelopment of the whole genital tract. The ovaries were only half the size of those in the control animal, and at the same time the whole growth of the treated animal was retarded. This experiment greatly stimulated treatment of the hypophysis for the purpose of producing involution of the uterus and ovaries. Hofbauer[16] created the term "hypophyseal castration." It is to be noted that Hofbauer's purpose was to produce a depressing effect on the secretory function of the hypophysis. Hofbauer's hypothesis was a failure. Werner[48] tried to influence menopause symptoms by treatment of the hypophyseal region and explained the good results as an effect on the vegetative nervous center, until Borak,[3] who repeated Werner's treatment on a greater material, introducing still another theory, insisted on the depressing effect of roentgen radiation on hypophysis and thymus. Holzknecht[3] is of the same opinion as Borak. The *congestion in the head, the sudden onset of perspiration, pruritus, rheumatic pain in the joints, cold hands and feet, some dermatoses of neurogenic base, backache*, etc., are only a few signs of vegetative nerve disturbances. This increase in sympathicus tonus is brought about through dysfunction of the ovaries (Langer).[24] Borak treated 274 cases over the hypophysis and reported in 80 per cent a complete disappearance of menopause symptoms by treating only this part of the body. The result was increased 15 per cent by irradiating the thyroid in addition. In all the cases treated no bad effect could be observed. That the roentgen effect in such cases is primarily a direct one on the vegetative nervous center and not on the hypophysis is more plausible from the following examples.

In Döderlein's clinic every patient with cancer of the uterus first receives roentgen treatment over the hypophysis, as used by Hirsch[15] and recommended by Hofbauer. Voltz,[47] reporting Döderlein's cases, thinks that he is stimulating the hypophysis in his cases (see Holzknecht and Borak, above). One thousand three hundred and twenty-six cases were treated over the hypophysis, and their observation was that this kind of treatment was never harmful and the general condition of the patient was better than without hypophyseal treatment. Simon,[41] who studied Widal's reaction of the hemoclastic crisis in the same clinic, found that the alimentary leucopenia was changed to leucocytosis immediately after application of roentgen radiation to the hypophysis. This change in Widal's crisis is explained by Simon as change of the vasomotor center through roentgen radiation. Heilig[14] who studied a case which received roentgen treatment over the hypophysis came to the conclusion, through elaborate clinical tests and observations, that not the hypophysis but the centrum of the vegetative nervous center was the one which was influenced by roentgen radiation, so that normal menses, increased polyuria without increased NaCl output, etc., resulted. Del Buono[5] does not come to a definite conclusion on the basis of his research to determine whether the effect of the treatment of the hypophysis is due to an influence on this gland of internal secretion or on the vegetative nervous center. Vischia[46] admits that all opinions attempting to explain the action of the irradiated pituitary on the uterovarian functional disturbances are purely hypothetical. Podljaschuk[34] treated the hypophysis of rabbits and dogs with roentgen radiation to study the effect a severely damaged gland could have upon the genitalia. In two series of experiments, no change in ovaries or testes could be observed which could be attributed to hypophyseal influence. These animal experiments and clinical research conducted by myself and by others confirm my belief that the roentgen effect is not

primarily on the hypophysis but on the vegetative nervous center. We might add that our experience has taught us that the more the vegetative nervous system is in a stage of hyperactivity, the less roentgen dosage is required to bring this system into balance.

How important a rôle the vegetative nervous system plays in the regulating mechanism of menstruation is well known. The roentgen effect on the vegetative nervous system and its influence on menstruation will be published soon. The object of this chapter is to demonstrate the possibility of influencing symptoms of hypersympathicotony by irradiating the correct vegetative nervous center. I believe that the thyroid field of Borak influences the cervical ganglion part in the same way as his hypophyseal treatment influences the diencephalon part of the vegetative nervous system. The technique of my roentgen treatment over the diencephalon in exaggerated menopause symptoms is the same as adopted for asthma patients (Figs. 5, 6 and 9). Six weeks after the first application, two fields, left and right side of the neck including the temporal region with 250 r each, might be repeated when necessary.

HYPERTHYROTOXICOSIS

Let us remember that our study of the roentgen effect on the vegetative nervous system has shown a greater irritability (Stage 1) of the treated vegetative nerves which passes gradually into Stage 2, the paralyzing or quieting effect of the roentgen irradiated nerve. Let us remember, furthermore, that a normal thyroid is practically roentgen or radium resistant to a normal roentgen dosage. From this point of view, our conception of the effect of roentgen radiation in hyperthyrotoxicosis changes considerably. The direct effect of roentgen radiation on the pathological cell, which is no doubt present, has, in my opinion been overvalued and the effect of roentgen radiation on the overirritated vegetative nervous system undervalued, if not wholly neglected. It will give us a better understanding of our therapeutic procedure if we concentrate our observation more upon the effect of radium or roentgen rays on the vegetative nerves.

It should now be clear why a smaller dosage of roentgen rays over the thyroid produces less alarming symptoms when the vegetative nervous system is entering Stage 1 with less excitability than if a larger dosage had been employed. As soon as the vegetative nervous system has entered Stage 2, which is in twenty-four or, at most, forty-eight hours, more roentgen radiation can be given with safety.

The older opinion about hyperthyrotoxicosis was that we had to deal with a sympathicus neurosis. Laignel-Lavastine[22] believes that vegetative nervous disturbances are the cause of hyperthyrotoxicosis. Whether a weak vegetative nervous system was inherited or brought on through environment, busy life, infection, toxins or psyche is for the internist to decide and he has to act accordingly. Chvostek,[4] and following him many others, reported good results obtained with galvanic treatment over the cervical medulla and believed therefore that Graves' disease was produced by overirritation of the sympathicus. Philippon, Gouin, and Bienvenue[32] treated only the stellar ganglion in a case of exophthalmic goiter and observed diminution of symptoms. We know that the thyroid gland which received roentgen radiation in the range of therapeutic dosage does not show histologically any change in its structure. Therefore, the explanation of the direct effect of roentgen radiation on nucleus and plasma or the chemical effect on the thyrotoxin is not enough to explain the roentgen effect satisfactorily. Furthermore, we have not a satisfactory explanation as to why roentgen application over different parts of the body influences hyperthyrotoxicosis symptoms. Jugenburg[18] reports that in elderly women in whom the roentgen treatment over the thyroid did not produce an improved condition, treatment over the hypophysis gave excellent results. Her idea is to influence an over-

active hypophysis. She gives four fields (two temporal, one frontal, and one occipital field, hard filter, 242 R each field), one or two fields a day. The day after treatment increased headache, hyperemia of the skin of the face existed (my Stage 1). After five days, reduction in metabolism and general improvement was observed. It is not necessary to credit the hypothetical overactivity of the pituitary gland with the improvement after roentgen treatment. Is it not easier to explain it as the paralyzing effect of the roentgen rays on the centrum of the vegetative nerve center in the diencephalon (base of third ventricle)? I have given roentgen treatment over this centrum in patients who presented all the symptoms of Basedow's disease and obtained a considerable diminution in basal metabolism by this treatment only. The roentgen effect over the thymus region has only been explained with theories. Mannaberg treated the ovaries with roentgen radiation and saw amelioration of Graves' symptoms. Zweifel[56] treated a patient over the spleen (see Groedel's asthma treatment) and saw a great improvement in his patients with hyperthyrotoxicosis symptoms. The *disturbed menstrual function*, *diarrhea*, *irregularities of heart*, briefly, all symptoms of an overirritated vegetative nervous system, which becomes gradually normal, can be explained through the reflex depressing effect of roentgen rays on distant ganglia. Surgery does not yield 100 per cent results in thyrotoxicosis. I believe that often, among other reasons, higher irritated ganglia and nerves are still in the state of overirritation, and the removal of some part of the system is not enough to bring the whole system into equilibrium. In such cases roentgen treatment over the correct centrum of the overirritated vegetative nervous center might bring the desired result. I believe that the field over the thymus region affects the ganglion stellatum (4th to 9th dorsal vertebrae) considerably, and if Nordentoft and Blume[29] have observed amelioration of symptoms when the thymus alone was treated, the depressing effect on the stellar ganglion and its branches is just as satisfactory an explanation as their belief that a hypothetical persistent thymus was influenced. It is a well-known fact that the additional thymus fields gives better results than the roentgen treatment of the thyroid alone. The additional roentgen effect on the stellar ganglion can be more easily understood than a theory which has not thus far been proved to be correct.

I realize how difficult it is to compare such different procedures as the surgical and roentgen treatment of this disease which, for satisfactory results, according to the data reported by roentgenologists, are in close agreement. The same explanation, however, might be applied to both. If surgery has reached its greatest perfection as far as thyrotoxicosis is concerned, roentgen or radium therapy certainly is only in its infancy, and if I am successful in showing a new road which might lead to better results, my efforts have been highly compensated. Eighty-two cases came to our department for roentgen treatment, 10 cases previously operated upon had shown recurrence, increase in basal metabolism, loss of weight, etc. It was found in not a few cases, treated in the standard way (two fields over thyroid, one over the thymus region, using the metabolism test as a measure of improvement) that the basal metabolism increased instead of gradually going down (Stage 1). This led me to irradiate higher situated ganglia (centrum of diencephalon) which I supposed to be overirritated. The result proved my assumption to be correct, as metabolism and general condition often distinctly improved under this technique of applying hard filtered roentgen rays to a higher center of the vegetative nervous system. The surgeon might find a greater percentage of improvement in his cases if, as a preparatory measure, each patient who came for operation received, during the time of preparation, two fields left and right side of neck including the temporal region (250 r) irradiating the vegetative centrum and

at the same time the sympathicus of the neck (Figs. 5 and 6). One field over the thymus region (500 r) might be given the next day. This field aims at the cervical ganglia. We do not consider a case of hyperthyrotoxicosis sufficiently treated as long as the patient's basal metabolism is higher than plus 20, and remains so for at least six months. We cannot make a definite statement as yet, but it is my impression that the exophthalmos disappears more quickly and oftener, provided the case is not of too long standing, with the field given over the diencephalon. Exophthalmos is explained as a congestion of the lymph, arterial, and venous systems of the retrobulbar tissues. Irritation of the sympathicus produces in the membrana orbitalis mucosa such a condition, and it seems that the paralyzing effect on such an overirritated sympathicus brings forth a normal blood and lymph supply.

NEURALGIA

There is a great confusion between the definitions of neuritis and neuralgia in general practice. The word "neuritis" is generally employed when, in addition to pain, symptoms of motor and sensory deficiency are observed. The cause of neuritis is generally toxic or is due to some considerable pressure from tumor, scar, exostosis, callus, deposits, deformation, flat feet, etc. Removing the cause cures neuritis. Histological findings in neuralgia are negative. Neuralgia is seen mostly in patients who show "neuralgia disposition" (Linstedt),[26] and this type of patient is mostly found in the neurasthenic class. Härtel[12] states that in his great experience he always found vegetative nerve disturbances present in his neuralgia patients. In trigeminal neuralgia, for instance, the theory that this is due to a disease of the fifth nerve (Quinke-Kulenkampf)[36] has not yet been proved. Härtel discusses the correlation, anatomically and physiologically, between trigeminus and sympathicus. He explains an attack of trigeminal neuralgia as an increased tonus in the sympathicus and a hypersensitiveness of trigeminus. The literature of roentgen treatment in neuralgia since Gocht (1897) has grown tremendously. We are interested in reports of cases treated by paravertebral application. Freund, Zimmern, Cottenot and Delherm gave their reports in many publications as early as 1912. Better results were obtained by sacrolumbar or second to fifth cervical paravertebral treatments than by direct treatment over the affected nerve. Their idea was to influence the inflammatory process at the roots of the nerves passing through the skeletal part of the vertebral column (radiothérapie radiculaire). Zimmern and Cottenot, as I have mentioned previously, have now accepted my explanation of the effect of roentgen radiation on the vegetative nervous system. Simonson[42] was one of the first to insist that roentgen rays must have a certain quieting effect on the nerves, a conclusion brought about, not by experiments, but by his complete study of roentgen literature (up to 1913) of the quieting effect of radium and roentgen rays in patients treated.

Our patients were systematically treated over the corresponding ganglia of the affected area. The increased pain which sets in a few hours later and lasts sometimes over days (corresponding to the dosage given) could be explained by us, but was not very well received by the patients and the referring physicians. We therefore lost many cases because the patient refused a second treatment or because the physician stopped further treatment, interpreting the reaction as a bad effect of roentgen therapy. That a great number of patients became well was credited to other medication. It is therefore of the greatest importance to advise patients and referring physicians regarding what might be expected. We believe that a reaction in the form of increased pain following roentgen treatment over the vegetative nervous center proves that the vegetative nervous system was in a state of hyperactivity. The greater the reaction, the greater the irritability present, provided always the same

dosage is applied. If there is no reaction after roentgen treatment the case should be carefully studied again and frequently the diagnosis has to be changed to neuritis.

TRIGEMINAL NEURALGIA

In 1897 Gocht reported a case of trigeminal neuralgia in a patient seventy-six years old, who, to be even slightly comfortable, had to be kept under heavy doses of morphine and whom he treated with roentgen radiation. The result was that morphine was no longer needed. It is noteworthy that some patients were relieved from their suffering by roentgen irradiation after alcohol injection and, in one case, after the resection of the ganglion Gasseri had been tried unsuccessfully. Every case of trigeminal neuralgia should receive roentgen treatment for the purpose of quieting down the overirritated sympathetic part. Attempts have often been made to explain the effect of roentgen therapy in this disease as an hyperemic effect. If this were the case, why is our best hyperemia producer, diathermy, often a failure? The dose which I found to give satisfactory results in trigeminal neuralgia was from 500 to 600 r. The ganglion Gasseri should always be included in the field. In all treated cases the reaction Stages 1 or 2 can always be observed. Opiates in relatively large doses may be necessary.

That neuralgia of the plexus brachialis or intercostal neuralgia reacts in the same favorable manner when treated over the corresponding ganglia can be readily understood. That the dosage needed in brachial-plexus neuralgia can be smaller is due to its anatomical position.

SCIATICA

The clinical symptom of sciatica offers such a difficult problem that it is not easy to determine which cases should be selected for roentgen treatment. Wilms[50] wanted the "rheumatic form" of neuralgia treated with roentgen radiation. This might give the best indication for this form of treatment, but just what we are to understand by "rheumatic form" can never be precisely stated.

We select for paravertebral lumbar roentgen treatment cases in which we have excluded a neuritis as far as possible. In these selected cases we found one symptom constantly present, namely, that the affected limb showed signs of vegetative disturbances. The affected leg was colder than the unaffected one and very often the patient was surprised when told so. He thought that the affected leg was burning but could feel for himself that it was much colder. Muscle turgor seemed to be diminished, difference in perspiration was often observed, spasm of the circulatory system often occurred, and the color of the skin was found to be different. Such symptoms influenced us to treat some of our arthritic patients also in the same manner, as we shall see later. Wiedhopf,[49] anesthetizing the sciatic nerve just at the point where the nerves pass the skeletal part of the vertebral column, found, in 19 out of 20 cases so treated the Lasègue sign still positive and he therefore believes that the neuralgia must have, in such cases, a central origin, and the pain extending all down the nerve must be a secondary neuralgia. Whether this neuralgia of the intralumbar roots is secondary, that is to say, is produced through an earlier myalgia (Linstedt) or, as we have observed in many cases through arthritic influence, is a matter of secondary interest. We found, like Linstedt, that in many cases myalgia of the lower dorsal and lumbar region was present, which led us to assume that we had to deal with a reflex neuralgia as Mackenzie[27] understands it. Pemberton[31] makes the same observation. He states: "The condition may begin as lumbago (myalgia of Linstedt) and after a variable period of two or three weeks the pain usually travels to the thigh through the popliteal space and down the calf of the leg."

The sciatic nerve originates from the 3d lumbar to the 3d to 4th sacral vertebrae. The corresponding spinal ganglion is situated in the region of the fourth lumbar

vertebra but its roots are still found at the height of the first, second or third lumbar vertebra. We understand now why early publications on roentgen treatment in sciatica reported better results when the nerve roots were treated (Zimmern and Cottenot's radiothérapie radiculaire). We understand also that their explanation of an anti-inflammatory effect of roentgen radiation was not satisfactory. In fact, the increased pain (Stage 1) after roentgen application certainly made many roentgenologists hesitate to try this technique on another case, as they most probably believed that they had made the inflammation worse than before. It is hoped that my observation may induce some to try this technique again. It is unfortunate that Stage 1 in sciatica was observed by us to be much longer, for instance, than in trigeminal neuralgia.* The mechanical part played by the myalgia must not be overlooked and physiotherapeutic procedure to relieve the spastic condition in the lower dorsal and lumbar muscular region should be continued until it has disappeared. As the nerve roots are quite deeply seated, deep therapy will bring quicker results. The older publications show uniformly that the doses with medium hard rays had to be repeated quite often before the desired effect could be obtained. We give four fields over the lower back in the manner shown in Figure 4, from 250 r to 350 r each field depending on the type of patient. If the patient is a hyper-nervous type only 200 r, two fields over the upper lumbar region paravertebrally, should be given. The use of opiates, before the treatment, might be advisable in such a patient. The next day, the two lower fields must be exposed. To wait until the pain has diminished would be a failure as when in surgery only a part of the ganglionectomy is performed. To obtain the desired result the same dosage is repeated, three to four days later, in some cases until 800 r has been given over each field. Premature conclusions should not be drawn because of observed failure in this technique. In women under forty years of age, the dosage should not exceed 400 r each field, and the angulation of the tube should be exaggerated in the lower fields from 40 to 45 degrees. It is understood that all neuralgia cases must receive physiotherapeutic treatment regularly.

* It is possible that the so-called irritation dosage of roentgen rays, in which so many roentgenologists believe, corresponds to my Stage 1. But as this stage passes invariably into Stage 2, this expression is misleading.

ARTHRITIS

As was pointed out in the preceding discussion of neuralgia, our frequent observation of vegetative nervous system disturbances in our arthritic patients impelled us to treat that group in the same manner, that is to say, by influencing the disturbed vegetative nervous system by means of applying roentgen radiation directly over the corresponding ganglia of the diseased part of the body. We thought we were justified in doing this for the following reason: Of 1,091 arthritic patients referred to our department between January, 1926 and January, 1931, more than two-thirds were persons, regardless of sex, past middle age. Even if our conception of the nature and treatment of arthritis is the same, on the whole, as that described by Pemberton, we believe that the disturbances of the vegetative nervous system which we found with "surprising frequency," are more important for close study and subsequent treatment than is generally supposed. The psychosis in arthritic patients who belong so often to the unfortunately called "neurasthenic type" should be studied just as well as the spinal region. Pemberton says, "Arthritis touches more fields of medicine than does any other disease." We must not overlook all the disturbances of the menopause which are well known to be disturbances of the vegetative nervous system, and we must not only hunt for focal infection but we must also see if hypertrophic changes of a knee, for instance, about which the patient complains, is not found *symmetrically* in the other knee in which there is no pain or

ache. This clinical sign alone would influence me in cases which do not make progress under normal physiotherapeutic procedure, to treat these over the lower lumbosacral region, with the distinct purpose of influencing the overirritated vegetative nerves. *The trophic, shiny skin, certain form of edema, sclerodermatic changes around the afflicted area and often below the diseased parts; change in the appearance of the nails, the longitudinal-striated brittle form, sometimes ashen-gray cyanotic in color* are a few signs which should be looked for as evidence of vegetative nervous system disturbances. Pemberton found that 60 per cent of all arthritic patients presented a delay in the rate at which sugar leaves the blood after ingestion by mouth and that this delay grows less or disappears after recovery from arthritis. He also found a disturbance of the peripheral blood flow and concluded that a certain local vasoconstriction in arthritic patients must be accepted. This corresponds to our findings and explains why patients complain so often about cold feet and hands. Magnus-Alsleben[28] found in animal experiments that not only the arterioles but even the capillaries of the muscle are under direct influence of the "sympathetic system." Resection of the sympathetic nerves changes the permeability, and metabolism is also greatly changed, not through change of blood supply, but through direct influence upon the "sympathetic nerves." These findings, together with the fact that Adson and Rowntree have recently thought along the same line, gave me more courage to try the paravertebral roentgen treatment in arthritic patients. But may I suggest that their sympathetic ganglionectomy and trunk resection in the treatment of chronic arthritis should be considered only when roentgen treatment over the corresponding ganglia has failed. The indication for surgical operation in arthritic patients given by Hench[13] can be extended for roentgen therapy of elderly people as they show vasomotor disturbances more often than the younger group.

SUMMARY

The effect of roentgen radiation on the vegetative nervous system was proved in animal experiments with a special technique by me in 1923 and my findings have been corroborated by others.

The effect of roentgen radiation on the vegetative nervous system is explained in a form of two stages: (1) irritating, (2) quieting effect. These effects are shown in examples in discussing different diseases of the skin and internal diseases.

An attempt is made to persuade radiologists to study and cooperate in these findings.

The desirability of trying roentgen treatment before surgical removal of sympathetic ganglia or trunk resection is advocated.

The technique presented might prove of value as a diagnostic test as well as a help in clinical research.

The roentgen treatment as described by me and compared with observations of other roentgenologists does not seem to show any permanent injurious effect on the patient.

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PRECONCEPTION OVARIAN RADIUM IRRADIATION OF THE ALBINO RAT (*MUS NORVEGICUS ALBINUS*)*

A BIOLOGICAL STUDY

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INTRODUCTION

THE Gynecean Hospital Institute of Gynecologic Research of the University of Pennsylvania has recently promoted an investigation of the health of children born after therapeutic, maternal, pelvic, radium or roentgen irradiation.[8–13,17–24] The study was both a clinical and an experimental one. The clinical part included a review of the world's literature, and the study of a large number of returned questionnaires, which dealt with previously unreported experiences. The maternal treatments fell quite readily into two categories, one, in which the treatment *preceded* conception, and the other, in which the embryo was irradiated *in utero*. It was concluded on the basis of these clinical studies that preconception irradiation *is harmless* to the health and development of subsequent children.

The clinical part of the investigation was supplemented by an experimental study. This personal experiment was carried out on the albino rat (*Mus norvegicus albinus*). A group of 128 of these animals was given severe, ovarian, radium exposures prior to being mated.[20,21] Of the total number, 58 conceived subsequent to treatment. The young of these irradiated animals were carefully observed. They were mated in turn, and the second generation was also studied in like manner.

Although from an examination of many clinical and experimental data from all possible sources,† it appeared that *preconception* irradiation was *not* injurious to the health of offspring conceived following maternal treatment, it was believed that further light might be shed upon the question by a careful examination of the ovaries of some of our irradiated animals. Observation of many thousand serial sections of the ovaries of 28 (chosen at random) of the 128 irradiated animals forms the basis for the present report.

RADIATION TREATMENT

The selection and care of the 128 animals, and the details of their irradiation are more fully recorded elsewhere.[20,21] However, a brief summary of the latter follows:

Healthy, virgin, pedigreed animals, secured directly from the Wistar Institute Colony, were irradiated at the optimum breeding age of four months. The treatments were given in the Radium Research Department of the Philadelphia General Hospital. Radium emanation (radon) was employed, in amounts approximating 500 millicuries. It was measured by means of an electroscope before and after each treatment, as a check against possible breakage of the glass radon-containing capsule during the treatment, with consequent loss of the radon. The applications were made upon the body surface, first over one ovary and immediately thereafter over the one on the opposite side. The radon was applied in a brass capsule 2 mm. in thickness, and was held in place by the bakelite holder as shown in Figure 1.

The 128 animals received radium exposures which varied from 600 to 1,300

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† The majority of clinical observers hold to the opinion that preconception maternal pelvic radium irradiation (therapeutic in amount) is harmless to the subsequent offspring. The majority of experimental studies confirm this assumption. However, Mavor, treating the eggs of the fruit fly with roentgen irradiation has brought forward evidence of a striking nature to indicate that preconception or prefertilization treatment is harmful.

millicurie-hours, as did the 28 forming the basis for this report (Tables I and II). Since more than 600 mc-hr. of treatment applied within the human uterine canal is very likely to induce a permanent or prolonged sterility period, a similar dose for an animal as small as a rat is therefore relatively large.

The severity of the treatment was indicated by the subsequent general reactions of many of the animals, such as lack of interest in food, the early appearance of diarrhea in the case of 2 of the animals recorded in Table I (Q-1 and N-1), and of dorsal burns which occurred in 2 others (M-5 and M-1).

In spite of large amounts of radiation, 12 of the 28 animals (Table I) remained fertile, as many as 5 litters being cast by one of them (E-2). However, the majority of the fertile ones threw only one or two litters, and then became sterile.

The 28 animals described in Table I were killed, and their ovaries were prepared for histologic examination. It was not possible to kill any of these animals at an early date following irradiation for several reasons. In the first place, part of the study consisted of determining the sterilization dose of radium as applied to the rat, while in the second place, an attempt was also being made to secure as many litters as

TABLE I

SUMMARY OF OBSERVATIONS ON RADIATION TREATMENT AND FERTILITY OF 28 ADULT FEMALE ALBINO RATS.

Identification	Radium Exposure in Millicurie-Hours	Interval Between Treatment and Mating Days	Interval Before First Litter Days	Number of Young	Interval Between 1st–2nd Litters Days	Number of Young	Interval Between 2nd–3rd Litters Days	Number of Young	Interval Between 3rd–4th Litters Days	Number of Young	Interval Between 4th–5th Litters Days	Number of Young	Interval Between Treatment and Death Days
F-2	600	14	Sterile										215
I-3	700	14	Sterile										216
D-1	800	6	Sterile										243
H-2	800	14	28	1	39	3	24	2	Sterile				303
H-5	800	14	68	2	44	3	Sterile						197
H-9	800	14	28	4	69	2	Sterile						243
I-2	800	14	Sterile										179
J-3	800	14	74	6	57	3	62	5	Sterile				289
E-2	900	6	26	1	22	4	60	4	56	9	67	6	351
AE-5	900	14	Sterile										128
G-7	900	14	Sterile										194
H-3	900	14	43	1	24	5	Sterile						186
U-1	900	14	55	3	Sterile								226
U-2	900	14	28	2	Sterile								226
U-6	900	14	Sterile										153
W-1	900	14	Sterile										146
W-6	900	14	Sterile										146
Z-1	900	20	Sterile										205
AD-1	900	14	27	1	21	3	Sterile						138
AE-2	900	15	24	1	23	4	55	6	Sterile				124
AE-6	900	15	32	6	32	6	Sterile						128
D-U	900	6	114	2	48	1	Sterile						282
Q-1	1200*												9
N-1	1300	15	Sterile†										143
M-5	1300	14	Sterile‡										142
M-1	1300	14	Sterile§										142
M-4	1300	14	Sterile										141
AC-5	1300	14	Sterile										142

* Not mated (diarrhea).
† Diarrhea.
‡ Dorsal burn.
§ Dorsal burn.

Summary of observations on radium radiation treatment, and the subsequent fertility of 28 adult female albino rats. The radium exposures varied from 600 to 1300 mc-hr. inclusive, half of each exposure being applied over each ovary. The majority of the animals were mated approximately two weeks after treatment. Only 12 of the 28 animals remained fertile. With one exception (Animal AE-2, killed twenty-two days after the birth of its last litter) all were sterile for more than sixty days before being killed.

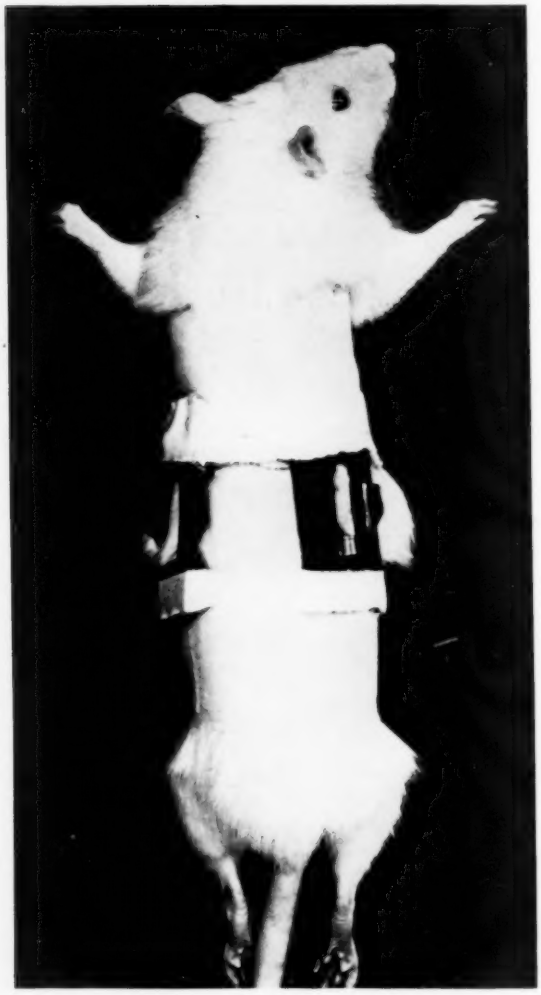

FIG. 1. Showing an adult white rat prepared for a radium exposure. The body is bound with adhesive plaster to limit motion, and two bakelite radium holders are in position over the ovarian regions. The brass capsule which holds the radon can be seen under the hinged cover of the holder on the right side of the animal.

possible from each irradiated animal, in order to study these young and their offspring.

METHOD OF OBTAINING AND PREPARING MATERIAL

All of the animals, with one exception, were killed by bleeding, during deep chloroform narcosis. In one case (Q-1) the animal died of irradiation enteritis, but within one hour the ovary was placed in the fixative solution (Heidenhain's "Susa" mixture used for all specimens). The ovaries, together with the corresponding oviducts and the uteri, were embedded by the celloidin-paraffin method. Serial sections 5 micra in thickness were made. These were stained with Heidenhain's hematoxylin, and counterstained with eosin. In 5 animals we compared the right with the left ovary. Since no histologic differences were observed, this comparison was omitted in the remaining 23 cases, and only one ovary of each remaining animal was studied. The data in Table II refer to only a single ovary of each of the 28 animals.

The amount of material which we have studied is comparatively small. Nevertheless it is sufficient to form the basis for a few remarks concerning some of the questions which have previously been discussed in the literature. For an extensive bibliography of the subject the reader is referred to the papers of Goldstein[9] and Murray.[25]

HISTOLOGIC FINDINGS

Bergonié, Tribondeau and Récamier[4] first called attention to the peculiar radiosensitivity of the ovary. Following their observations, subsequent studies upon this subject were carried out, many of which included careful histologic examinations. In spite of these, gaps still remain in our knowledge, because the normal histologic structure of the ovary, and especially the nature of the formation of the oöcytes, are as yet imperfectly understood. Most of the previous authors drew their conclusions from observations upon some form of rodent, such as the rabbit, white mouse or white rat, starting out with the assumption that the number of oöcytes in these forms is fixed. This means that every oöcyte is laid down in the embryonic ovary, and that none are formed after full development is reached. This assumption led to a second one, namely, that all of the oöcytes in irradiated ovaries are exposed to the radium or roentgen rays. And in case oöcytes were found long after treatment, their presence was explained on the ground that these

possessed a higher resistance than the ones which did not survive.

Recent careful histologic studies upon the ovaries of rodents prove that all oöcytes are *not* laid down before birth. Allen,[2] Papanicolaou,[26] Allen, Kountz and Frances,[1] Butcher,[5] and very recently

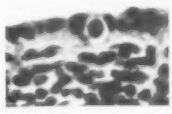

Fig. 2

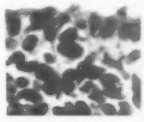

Fig. 3

Fig. 2. Showing the formation of a new oöcyte (Type 1—Hargitt) in the germinal epithelium of one of the ovaries taken from an animal which had been exposed to 1300 mc-hr. of radium, and which was killed 143 days following treatment (Animal N-1, Table 1).*

Fig. 3. Showing a cell sinking below the germinal epithelium and differentiating into an oöcyte. It is being followed by a few undifferentiated germinal epithelial cells, one of which is larger than the others.

Hargitt,[14,15,16] have found that the formation of oöcytes in the ovaries of rodents is

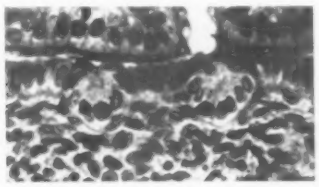

Fig. 4. Showing epithelial buds in the process of detachment from the irradiated germ layer, as observed in the ovary of an animal which received 900 mc-hr. of irradiation, and which was killed 357 days later (Animal E-2).

a continuous process. A short summary of their results follows:

At every estrual period as many as 400–500 new ova develop from the germinal epithelium of each ovary. However, only 4 or 5 of these mature. All of the remaining ones degenerate prior to the onset of the succeeding period, none of the primary follicles remaining latent. Therefore primary follicles, if present, must always be considered as having recently formed. Though these statements apply strictly only to the ovaries of non-irradiated rodents they are of great value to us since our experimental animal, the white rat, is also

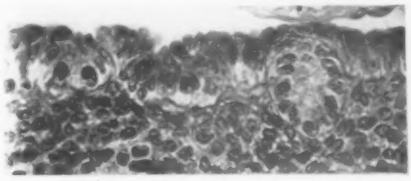

Fig. 5. From ovary of Animal E-2. Showing epithelial "pearls" forming in the germinal layer (on the left), also the detachment of a large "pearl" from the germ layer (on the right).

a rodent. Because exact knowledge was available concerning the histology of the normal, *non-irradiated* ovary, it was possible to interpret more easily the changes observed in the *irradiated* ones.

The first question which we put to ourselves, in this investigation, was the following: Is there any evidence to be gained from a study of irradiated ovaries to indicate that the germinal epithelium continues its oöcyte formation after such treatments?

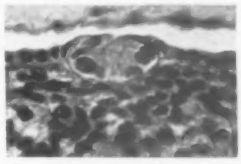

Fig. 6. Showing epithelial buds in the process of detachment from the irradiated germ layer, as observed in the ovary of an animal which received 900 mc-hr. of irradiation, and was killed 128 days after its exposure (Animal AE-6).

Under normal conditions, Hargitt distinguished two types of oöcyte formation in the rat. In one, an epithelial cell differentiates into an oöcyte before becoming detached from the germinal layer.

In the other type, variable-sized groups of undifferentiated epithelial cells first detach from the germ layer. Later one of these cells differentiates into an oöcyte,

* All high power photomicrographs were taken using magnification, i.e., Zeiss Apochr. Obj. 4 mm., comp. oc. 10x.

TABLE II

HISTOLOGIC FINDINGS IN 28 IRRADIATED RAT OVARIES.

Identification	Radium Exposure in Millicurie-Hours	Interval Before Death in Days	Germinal Epithelium		Primary Follicles with oöcytes	Epithelial Pearls	Secondary Follicles	
			Structure	Functional Activity			with oöcytes	without oöcytes
F–2	600	215	Normal	++	Very few; only 2 normal ones seen	Few	2 small normal ones; 5 large degenerated ones	None
I–3	700	216	Normal	++	None	Many	None	None
D–1	800	243	Normal	+++	One	Many, the larger ones show signs of degeneration	None	Two very large
H–2	800	303	Normal	++	Few	Many	A few of the smaller ones look normal. The rest and all the larger ones show degeneration	None
H–5	800	197	Partly absent, remainder desquamating	o	None	Very few	None	None
H–9	800	243	Normal	o	None	Few	None	None
I–2	800	172	Normal	o	None	Only a few of the smaller ones; many larger ones	None	None
J–3	800	289	Normal	++++	Many	Not many	All sizes of follicles, in normal and degenerative stage	Few
E–2	900	357	Normal	+	None	Few	None	None
AE–5	900	128	Normal	+	Few	Many, mostly large ones	Many, but most showing degeneration	Few
G–7	900	194	Normal	+	Very few	Many	Few; slight degeneration	None
H–3	900	186	Normal	++	Very few	Many	A few, most of which show degeneration	None
U–1	900	226	Normal	+	None	Many	None	None
U–2	900	226	Absent; ovary fused to its environment	o	None	A few large and degenerating	None	None
U–6	900	153	Absent; ovary fused to its environment	o	None	Very few, large and degenerating	None	None

Table II (*Continued*)

HISTOLOGIC FINDINGS IN 28 IRRADIATED RAT OVARIES.

Cysts	Corpora Lutea	Blood Vessels	Mucous Membrane of Uterus	Mucous Membrane of Oviducts	Remarks
Few small	2 large and fresh; the rest small and in the regressive stage	Normal	Normal, with few desquamating cells in the lumen	Normal	An oöcyte in Uterus 17 mm. from the oviduct
Many	Few, all small, in the regressive stage	Normal	Normal	Normal	None
5 very large; one 3 mm. in diameter	Few, very small; in the regressive stage	Intima of the arteries very thick; veins normal	Filled with white blood cells penetrating into the epithelium and into the lumen; many wandering macrophages	No lumen	Macrophages seen in the blood stream of ovarian veins
Few	Many, but in the regressive stage	Normal	Normal	Normal	None
Few	Few in regressive stage	Intima thick in the arteries, veins look normal	Many leucocytes in connective tissue, epithelium and lumen	Lumen gaping; epithelium simple, cuboidal	Macrophages around the ovary
Very few	A few extremely small, and in the stage of late regression	Normal	Normal	Normal	None
Very few	One only; and in regressive stage	Normal	Normal	Normal	None
Few	Many, of different sizes and stages of regression	Normal	Normal	Normal	None
Few	Few, small, and in regressive stage	Normal	Normal	Normal	None
Few	Many; mostly large and in the regressive stage	Normal	Normal	Normal	None
Few	Many, all sizes and stages	Normal	Leucocytic infiltration	Normal	None
Few	Many in all stages and sizes	Normal	Slight leucocytic infiltration	Normal	None
Few	Only remnants	Normal	Normal	Normal	None
Few	Remnants	Thick intima, narrow lumen	Leucocytic infiltration	No lumen	None
Few	A few corpora albicantia	Thick intima, narrow lumen	Normal	Largest part has no lumen, rest is lined with simple cuboidal epithelium	The environment of the ovary is crowded with large cells of the mononuclear type

TABLE II (*Continued*).

HISTOLOGIC FINDINGS IN 28 IRRADIATED RAT OVARIES.

Identification	Radium Exposure in Millicurie-Hours	Interval Before Death in Days	Germinal Epithelium		Primary Follicles with oöcytes	Epithelial Pearls	Secondary Follicles	
			Structure	Functional Activity			with oöcytes	without oöcytes
W–1	900	146	Normal	o	None	Few	None	None
W–6	900	146	Normal	+	None	Many	Few small and one large; but all showing degeneration	None
Z–1	900	205	Normal	o	None	Very few	None	None
AD–1	900	138	Normal	o	Only two	Few	Only one, small and abnormal	None
AE–2	900	124	Normal	+	Eleven	Few	Nine; none normal	None
AE–6	900	128	Normal	++	Many	Very many	Many small ones, only one large; one with abnormal oöcyte	None
D–U	900	282	Normal	o	None	Very few	None	None
Q–1	1200	9	Normal	++++	None	Many small ones	None	None
N–1	1300	143	Normal	+	None	Many	None	None
M–5	1300	142	Normal	+	None	Many	None	None
M–1	1300	142	Part normal and part desquamating	o	A few	Few	A few, but all showing degeneration	Few
M–4	1300	141	Absent; ovary fused to its environment	o	None	Degenerating remnants	None	None
AC–5	1300	142	Normal	+	Very few	Many	Three	None

while the remaining ones give rise to the follicular epithelium. The first type of oöcyte formation occurs far more frequently, under normal conditions, than does the second type.

In our study, the ovaries of 17 out of 28 irradiated animals exhibited a germinal epithelium which was actively forming oöcytes or epithelial buds. Single epithelial cells of the germ layer differentiated directly into oöcytes, exactly as described by Hargitt, as being the most common mode of normal oöcyte formation. This method of origin, however, was only *rarely* observed in the irradiated ovaries. Its form of development is illustrated in Figures 2 and 3, the photomicrographs being made of the ovary of Animal N-1.

On the other hand, the process which was described by Hargitt, as the second and rare type of follicle formation, was *frequently* noted by us. In the ovaries of

Table II. (*Continued*)

HISTOLOGIC FINDINGS IN 28 IRRADIATED RAT OVARIES

Cysts	Corpora Lutea	Blood Vessels	Mucous Membrane of Uterus	Mucous Membrane of Oviducts	Remarks
Few	None	Normal	Normal, few macrophages in the deeper layers of the connective tissue	Normal	None
Many	Few and very regressive	Normal	Normal	Normal	None
Many	One corpus albicans	Normal	Normal	Normal	None
Many	Three; all small and in regenerative stage	Normal	Normal, few macrophages deep in the connective tissue	Normal	None
Many	Many, all in the regressive stage	Normal	Normal	Normal	None
Many	Many, all in regressive stage	Normal	Normal	Normal	None
Many	None	Normal	Normal	Normal	None
Very many	Irregular groups of cells, which resemble cells of the corpus luteum	Normal	Normal	Normal	None
Many	Only four, all in the regenerative stage	Normal	Normal	Normal	None
Many	A few, all in regenerative stage	Normal	Normal	Normal	None
Many, one very large	Few, all in regressive stage	Endothelial desquamation	Desquamation	Desquamation	Endothelium of the peritoneum desquamating
Few	Only remnants	Intima thick	Normal	No lumen	Oviduct and surrounding tissue contain many macrophages
Few	Few, all in regenerative stage	Normal	Leucocytic infiltration	Normal	None

Summary of the histologic findings resulting from a study of a single ovary (cut serially) of each of 28 adult albino rats, subjected to radium exposures prior to being mated. In the fifth column marked "Functional Activity of the Germinal Epithelium" the degree of activity is indicated by +. A single + denotes the minimum of activity to be noted, while ++++ registers the maximum of such activity.

certain of our animals one might observe in practically every portion, groups of epithelial cells budding from the germ layer (these cases are marked ++++ in Table II). In the ovaries of some animals this process was observed less frequently, and appeared to be localized to small areas of the ovarian surface (these have been marked + in Table II). Figures 4 and 5 (Animal E-2) and Figure 6 (Animal AE-6) indicate that this epithelial proliferation into the stroma is identical with that which Hargitt found under normal conditions. These observations suggest that in many cases, in spite of severe irradiation (600–1300 mc-hr.) the germinal epithelium re-

tains its power of producing oöcytes and epithelial buds for a long period, i.e. as long as 357 days, as in the case of Animal E-2.

Oöcytes, normal in appearance, were found in the primary follicles of the ovaries of 12 of the 28 irradiated animals. Were these oöcytes subjected to the irradiation, or did they arise subsequent to treatment?

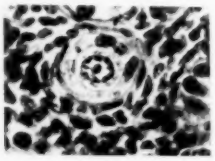

FIG. 7. Showing primary follicle possessing a histologically normal oöcyte, observed in the ovary of an animal which received a severe degree of irradiation (1300 mc-hr.), the animal being killed 142 days after treatment (Animal AC-5).

Previous authors believed that they were *not* formed after treatment, and hence must have been subjected to the irradiation; that they survived because of their high individual resistance, whereas the more susceptible ones degenerated. We are inclined to believe that differences in resistance occur. The presence of a few oöcytes, shortly after irradiation with lower exposures, may be explained on the ground that these cells had a higher resistance than the ones which did not survive. Our observations were made upon heavily irradiated ovaries, which were treated a long time before the animals were killed. In view of these facts, it is difficult to explain the presence of the primary oöcytes on the basis of their higher resistance.

Light may be thrown upon this problem by comparing observations made upon different animals. The ovary of one animal (Q-1) was studied nine days after an exposure of 1200 mc-hr. In this organ not a single oöcyte was found. The irradiation destroyed all of the primary and secondary oöcytes within a very short period. In a second case (Animal I-2), the exposure was relatively lower (800 mc-hr.), but in spite of this no oöcytes were seen 172 days after irradiation. These two observations might be compared to a third (Animal AC-5). Thirteen hundred millicurie-hours of irradiation were employed in the treatment of this animal, and still histologically normal, primary oöcytes could be seen 142 days after treatment. Figures 7 and 8 show that the oöcytes found in Animal AC-5 were histologically normal.

No oöcytes were seen in the ovaries of the animals subjected to the two smaller sized doses of irradiation, nine and 172 days respectively following treatment. It would be difficult to believe, therefore, that oöcytes could survive for 142 days following a still larger degree of exposure, 1300 mc-hr. as against 800 and 1200 mc-hr., solely on the ground of the high resistance of the oöcytes found in the latter animal. That such marked differences in the resistance of individual oöcytes may occur is hard to imagine.

Another point may be considered in this connection. As mentioned above, under normal conditions primary follicles either continue to develop or degenerate. They neither remain latent, nor do they survive the succeeding estrual cycle. In our experiments the intervals between irradiation

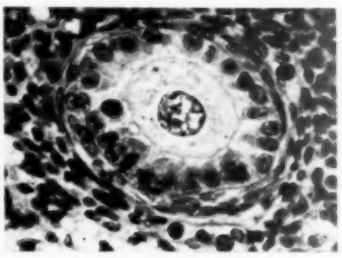

FIG. 8. A larger primary follicle than the one shown in Figure 7, taken from the same ovary.

and death varied from 124 to 357 days. These figures give an average of approximately 200 days, which represents about 50 estrual periods, in the case of the rat. Since, normally, primary oöcytes do not survive the succeeding period, it is extremely unlikely that primary follicles in irradiated ovaries might survive 50 such

periods, when it is believed that severe irradiation devitalizes rather than stimulates living tissue.

From these two sets of personal observations, we conclude that the primary oöcytes are new formations; they were not present at the time of treatment. On the contrary, they were formed shortly before the animal was killed. Therefore, in any further discussion in this paper they will be considered as such.

The above observations raise the question: What is the fate of these histologically normal-appearing primary follicles? In the ovaries of 12 of our 28 irradiated animals, secondary follicles were observed, but in only 6 of these animals were the oöcytes histologically normal in appearance. Secondary follicles, above the medium size, were never completely normal, while fully developed Graafian follicles were never observed. But in view of the fact that in exceptional cases we found a few large and fresh corpora lutea, we are inclined to conclude that follicles had ruptured, and that

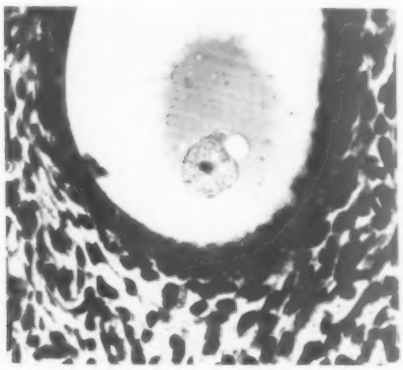

Fig. 9. Section through the nucleus of an oöcyte found in the lumen of the uterus. This belonged to animal F-2 which received 600 mc-hr. of irradiation and was killed 215 days later.

oöcytes had been discharged from certain ovaries shortly before the animals were killed.

As further proof that oöcytes may be discharged from irradiated ovaries, one was actually observed in the uterine cavity of Animal F-2, 17 mm. from the oviduct. The size and shape of this cell bore witness to the fact that it was undoubtedly an oöcyte. Its degenerated condition suggested that it must have been discharged

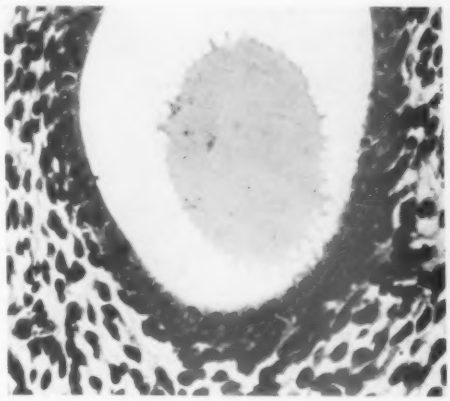

Fig. 10. Section through the middle of the oöcyte shown in Figure 9. This cell shows signs of degeneration.

several days before the animal was killed (Figs. 9 and 10).

Since the development of the oöcyte from the stage of primary follicle to the stage where it was found in the uterus could be traced, it seems justifiable to draw the conclusion that germinal epithelium, subjected to severe radium irradiation, in exceptional cases is able to produce primary oöcytes and follicles which may pass through all the morphological phases of normal follicle formation.

From a study of Table 11 it is evident that, with few exceptions, the germinal epithelium was active in the process described by Hargitt, as that of follicle formation of the second type, i.e., in which the larger or smaller groups of cells were detached from the surface epithelium. In spite of this activity, in only a few cases (12) did we observe normal primary follicles and oöcytes.

This fact suggests that normal oöcytes do not develop in every group of cells which become detached from the germ layer. The cell groups, separated from the germ layer, form small "pearl-like" structures, which in some respects resemble normal follicles.

In some cases their centers are occupied by a single cell, which in no way resembles an oöcyte, but resembles the surrounding cells. Such a "pearl-like" structure is shown in Figure 11, taken from Animal F-2.

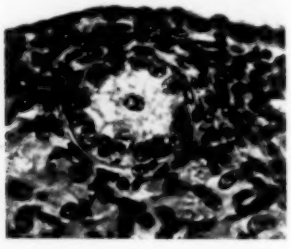

FIG. 11. Showing an epithelial "pearl" of medium size (33 micra). Its center is occupied by a small cell, which is histologically normal and resembles the other cells of the "pearl."

For comparison a normal follicle, observed in a normal non-irradiated ovary, is shown in Figure 12. The "pearl" of the irradiated ovary and that of the non-irradiated follicle are approximately the same size, the latter being slightly the smaller of the two. A normal oöcyte is seen in the follicle taken from a non-irradiated ovary (Fig. 12), whereas none is present

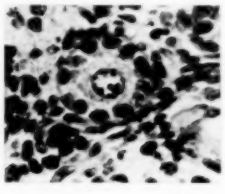

FIG. 12. Showing a primary follicle possessing a normal oöcyte. This was taken from a *non-irradiated* ovary for the purpose of comparison with the epithelial "pearl" shown in Figure 11.

in the "pearl" of the irradiated ovary seen in Figure 11. Its place is occupied by an indifferent epithelial cell, which cannot be considered a degenerated oöcyte, since it exhibits no signs of degeneration. Its nucleus and cell body exhibit a normal structure resembling the rest of the cells forming the epithelial "pearl." Previously normal oöcytes undergoing secondary degeneration always show some characteristics, by the aid of which they can be recognized as such (oöcytes).

Most of the epithelial "pearls" originating from the germ layer do not contain a central cell. Some of the "pearls" are very small because only a few epithelial cells

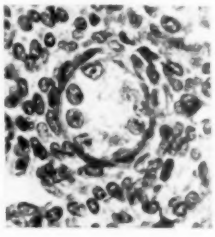

FIG. 13. Showing an epithelial "pearl" seen in the ovary of an animal which received 1300 mc-hr. of radium exposure, and which was killed 142 days after treatment (Animal M-5).

become detached at one time (Fig. 4). When groups composed of many cells become detached, they may form larger "pearls" (Fig. 5), or irregularly shaped cords. In both the "pearls" and cords, the

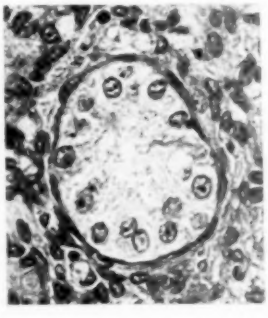

FIG. 14. An epithelial "pearl" larger than the one shown in Figure 13, taken from the same ovary.

nuclei of the epithelial cells have a peripheral position, close to the base of the cell, which is its broadest part, whereas toward the center the cell body is narrower, often showing irregularly shaped protoplasmic processes. In case the center of the "pearl" is not occupied by an "indifferent" cell, this area is filled by the above-mentioned protoplasmic processes of the surrounding cells. From a study of many thousand sections, there is no indication, in our opinion, that these "pearls" arise

from any portion of the ovary, except from the germinal epithelium. Their origin, therefore, is identical with that of normal follicles, though they differ from the latter in a most important respect, namely, that no oöcyte is differentiating in them, as occurs under normal conditions (Hargitt). We conclude that these epithelial "pearls" grow to a certain extent. Many of their cells exhibited mitotic division. Well-pronounced theca was formed around them. Figures 13 to 15 inclusive show a series of "pearls" of different sizes taken from one ovary (Animal M-5). The diameter of the

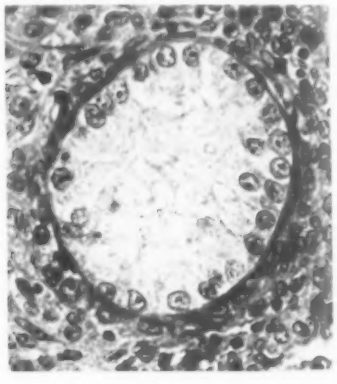

Fig. 15. Same as Figures 13 and 14. To illustrate the various sizes of "pearls."

largest "pearl" was 80–90 micra. In some of the large "pearls," cavity formation was observed which might be filled with liquid. These "pearl-like" structures may degenerate in any stage of growth. The theca weakens on one side and completely disappears (Fig. 16). The cells of the epithelial "pearls" then become mixed with the stroma cells of the ovary (Fig. 17), giving rise to groups of epithelioid cells.

Brambell and Parkes[3] explain the presence of epithelial "pearls" on a different basis. Two days after irradiation they observed oöcyte degeneration in many primary follicles. Seventy-three days after treatment, they found structures built from indifferent epithelial cells, which they termed "anovular follicles." They assumed that the latter, prior to irradiation, had contained true oöcytes which degenerated because of the irradiation, whereas the follicular epithelium had survived the treatment. From our study of the white rat we found that if the oöcyte starts to degenerate the entire follicle does so, quickly

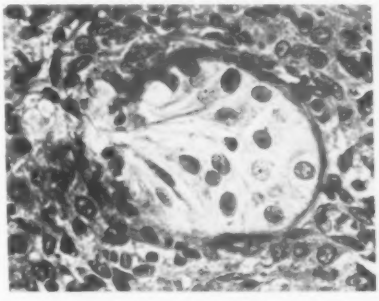

Fig. 16. A degenerated epithelial "pearl." Showing unilateral disappearance of the theca, and admixture of the epithelial cells with those of the stroma.

and completely. There is no doubt that a few days after irradiation some ovaries may exhibit follicles with degenerated oöcytes, and normal follicular epithelium. Never-

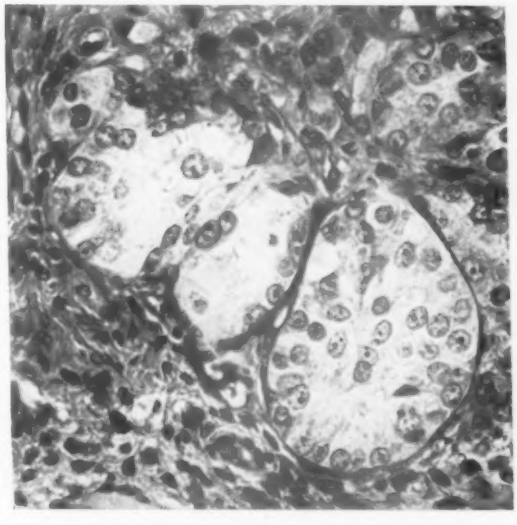

Fig. 17. A group of degenerating epithelial "pearls" giving rise to the epithelioid cells of the stroma.

theless, we were unable to find evidence in Brambell and Parkes' paper for the belief that follicular epithelium, in a fair condition, may survive the death of the oöcyte for a period of seventy-three days. Our material rather indicates that the degen-

eration of the oöcytes is accompanied by the desquamation of the follicular epithelium and therefore it is hard for us to believe that the epithelial "pearls" observed in our material, 357 days following treatment, were "anovular follicles" in which the irradiation destroyed the oöcytes, while the follicular epithelium survived and in many cases still showed the regular arrangement of the epithelial cells.

The nature of these epithelial "pearls" is better understood when it is known that we have evidence to support the view that new small "pearls" form (Figs. 3, 4 and 5). It is also a fact that the very large ones usually show signs of degeneration. These two extremes are connected by a series of transitional forms. The new formation, growth and degeneration of the epithelial "pearls" suggest that they are not "anovular follicles"; that they never contained oöcytes and that they were not present at the time of irradiation. Nevertheless the "pearls" imitate the growth of normal follicles to a certain extent. The epithelial cells multiply, theca develops around them, and also a cavity, filled with liquor, may appear in the center. This imitation, however, is very incomplete. Degeneration begins before the "pearls" reach a diameter of 100 micra.

Light is thrown upon the nature of the germinal epithelium by the fact that its activity in forming oöcytes and epithelial "pearls" is related to its histologic condition. In the ovaries of Animal H-5, only a small part of the germinal epithelium was found to be histologically normal, and only a few small epithelial "pearls" were found. In the ovaries of Animals U-2 and U-6, there was no germinal epithelium present. In the ovaries of these latter animals only a few very large epithelial "pearls" were found. These were practically all in a state of degeneration, which fact indicates that they had formed long before the animals were killed, i.e., when the germinal epithelium was more likely normal. The ovaries of another animal (M-4) presented the same picture, whereas in almost all ovaries in which the germinal epithelium was histologically normal, a few normal oöcytes, or at least a large number of epithelial "pearls," were observed. Therefore it is concluded that the germinal epithelium is able to produce oöcytes with normal structure and epithelial "pearls" only as long as it can be considered histologically normal. On the other hand, histologically normal germinal epithelium does not always produce such structures as those mentioned above.

The impression was gained from a study of the literature that the cysts which were observed in irradiated ovaries arose from follicles which contained normal oöcytes prior to treatment. The smaller cysts are supposed to have formed following the disappearance of the oöcytes from the primary follicle, to be replaced by liquor. The larger follicles already contained liquor, and when the oöcyte and the cumulus disappeared, the larger cysts resulted.

In Table II, two columns are designated "secondary follicles without oöcytes" and "cysts." In the first, all structures have been grouped, the cavities of which were lined with typical granulosa cells. There was no doubt in our minds that these structures originated from follicles in which oöcytes had previously existed.

Grouped in the other column, marked "cysts," were those small or large cavities filled with liquor, which were lined with a single layer of epithelial cells. It was impossible to determine the origin of these so-called "cysts." They may have arisen from follicles, previously normal, which had subsequently degenerated to a marked degree. But it must be remembered that the epithelial "pearls" in our material also exhibited cavity formation, and in some instances this was filled with liquor. It would seem that these "pearls" may also give rise to "cysts."

In the past, two reasons have been advanced to explain the changes observed in ovaries following irradiation: (1) that they were brought about by direct action on the tissues, and (2) that the degenera-

tive processes resulted indirectly from the alterations in the blood supply induced by the treatment.

The blood vessels of the ovaries of 22 of the 28 irradiated animals were observed to be histologically normal. The blood vessels in the remaining 6 animals exhibited endarteritis. In these latter animals the ovarian tissue degeneration, in general, was no more marked than in the case of the 22 animals possessing normal-appearing, ovarian blood vessels. These findings suggest that the ovarian degeneration following irradiation does not depend primarily upon indirect influence through the medium of the vascular system.

Another point of interest arises in this connection: Does the ovarian degeneration affect the mucous membranes of the other generative organs? In 16 of the 28 irradiated animals, the mucous membranes of the uteri and the oviducts were histologically normal, resembling the membranes of non-irradiated animals in the resting period between two estrual cycles. This was observed in spite of the varying degrees of degeneration found in the respective ovaries of these animals.

In the ovary of Animal I-2 only one corpus luteum was observed. This was degenerated. In the ovary of Animal Q-1 no corpora lutea were seen, but some cells were present which appeared to be remnants of the latter. In Animal Z-1 (Fig. 18) only a single corpus albicans was found. In spite of these observations the mucous membranes of the uteri and oviducts of these animals were histologically normal (Figs. 19 and 20).

The mucous membranes of the oviducts of 5 other animals were histologically normal, while their uterine mucosa exhibited signs of degeneration. The reverse condition was observed in 2 additional animals. The mucous membranes of the uteri of the latter animals were normal, while those of the oviducts were degenerated. In the remaining 5 of the 28 animals the membranes of both the uterus and oviduct exhibited degeneration. From these observations it may be concluded: (1) that the condition of the mucous membranes of the uterus and that of the oviduct is not influenced directly by the degeneration process of the ovary, following

Fig. 18

Fig. 19

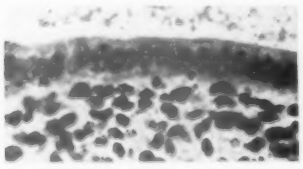

Fig. 20

Figs. 18, 19 and 20. Photomicrographs of the ovary (Fig. 18), mucous membranes of the oviduct (Fig. 19) and uterus (Fig. 20) taken from the same animal (Z-1). In spite of the severe degeneration of the ovary, the mucous membranes were found to be of normal structure.

irradiation, and (2) that the condition of the mucous membranes of the uterus and of the oviducts are not dependent upon each other.

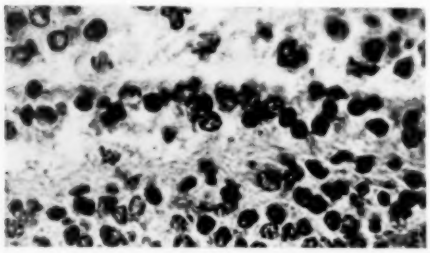

FIG. 21. Showing germinal epithelium desquamating from the surface of the ovary (Animal M-1).

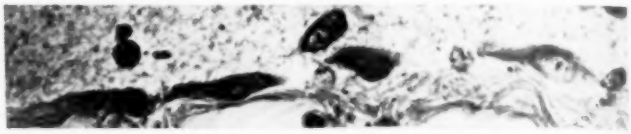

FIG. 22. Showing mesothelial cells in the process of detachment from the peritoneum (Animal M-1).

In previous papers, little mention has been made concerning the final steps of ovarian degeneration produced by irradiation. The present material offered an opportunity for such a study.

Almost all structures characteristic of the normal were missing from a few of the studied ovaries. Follicles, epithelial "pearls" and corpora lutea were absent.

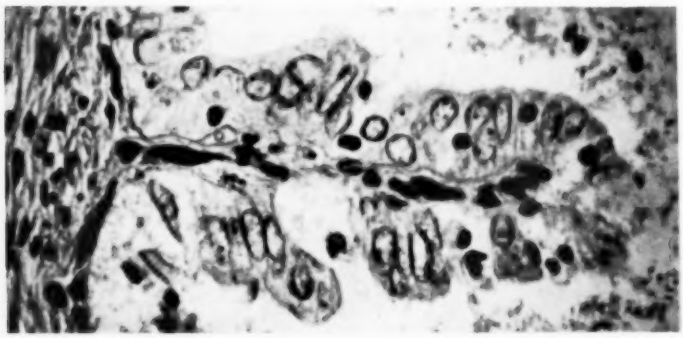

FIG. 23. Degeneration of the epithelial cells of the oviduct. These cells are losing their cilia; their nuclei exhibit pycnosis. A few of the cells are already detached from the connective tissue (Animal M-1).

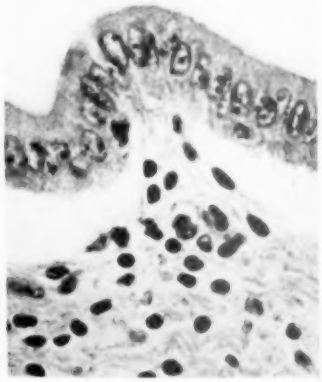

FIG. 24. Degeneration of the mucous membrane of the uterus. The epithelial layer is separated from the connective tissue (Animal M-1).

Many epithelioid cells were distributed throughout the stroma. In this heterogeneous tissue, blood vessels of various sizes were observed, some of which were normal and some showed signs of degeneration. At certain stages of the degeneration, the cells of the germ layer showed a tendency to desquamate. Single cells in some places and groups of these cells in other regions were detached from the surface of the ovary, and appeared to be suspended in the fluid of the peri-ovarial cavity (Fig. 21). Where the detachment of the germ layer was complete the ovarian tissue adhered to the tissues of its environment. The detached epithelial cells had lost their characteristic features and exhibited varying degrees of degeneration. The mesothelial cells in the region which was exposed to the irradiation were separated from the peritoneum. These mesothelial cells, between the suspended germinal epithelial cells, were easily recognized by reason of their size and oval shape (Fig. 22). The epithelial cells of the mucous membrane of the oviduct had lost their cilia; their nuclei exhibited pycnosis, and finally these

cells had separated from their base, and appeared to be lying free in the lumen of the oviduct (Fig. 23). The lumina of the sections of the oviduct, in which the epithelium was missing, were obliterated. The epithelial cells of the mucous membrane of the uterus were separated in like manner (Fig. 24).

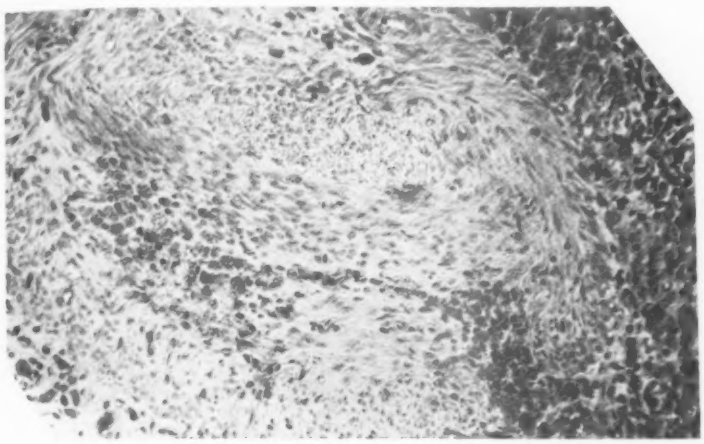

Fig. 25. Macrophages penetrating the muscle coat of the oviduct, and phagocytizing the mucous membrane (Animal M-4).

The degenerating oviduct and uterus were invaded by a large number of macrophages. The latter had phagocytized dead or dying tissue particles, and each one contained a large amount of ingested, pigmented detritus. In Case M-4, macrophages were seen penetrating the muscle coat toward the lumen of the oviduct, phagocytizing the mucous membrane (Fig. 25). The macrophages, filled with pigmented detritus, had penetrated to the blood stream through the walls of capillaries and post capillaries (Fig. 26).

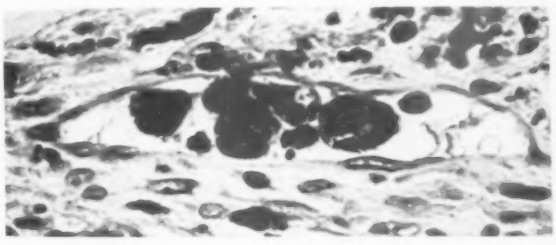

Fig. 26. A capillary containing macrophages filled with ingested, pigmented material. One of the latter is seen passing through the endothelial wall of the blood vessel (Animal M-4).

Sometimes many macrophages were seen in the larger ovarian veins (Figs. 27 and 28). It was practically impossible to determine the source of origin of the macrophages which were found in the irradiated areas. Clark and Clark,[7] have shown that monocytes of the blood stream pass through blood vessel walls and enter the tissue spaces. There they become transformed into cells which have a high degree of phagocytic activity. These macrophages loaded with ingested food may return through the blood vessel walls into the blood stream (Figs. 27 and 28).

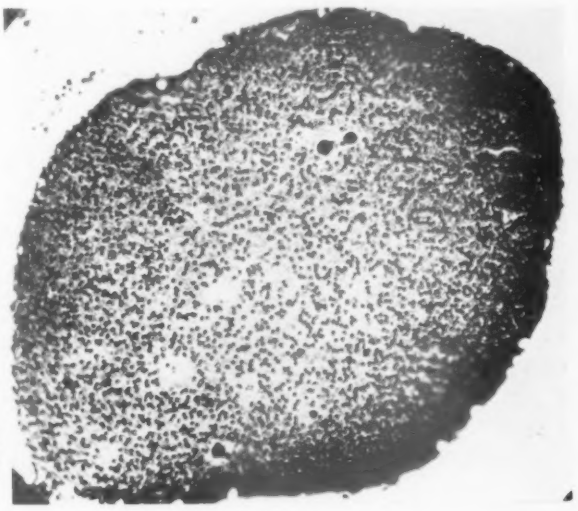

Fig. 27. Low power picture of an ovarian vein (Animal D-1). Pigmented macrophages are visible among the blood cells.

From a study of our material it is impossible to determine definitely whether these macrophages come from the same source as those observed by Clark and Clark. Certain observations indicate this possibility. An unusually large number of monocytes was frequently observed in the

small vessels, especially in the capillaries of the ovary and of the surrounding tissues. Their migration from the blood vessels to the tissues could not be observed, but many cells which exhibited morphologic features resembling those of monocytes were found around the smaller ovarian vessels.

Our observations, as well as those of others, indicate the destructive nature of irradiation upon ovarian tissue. Though

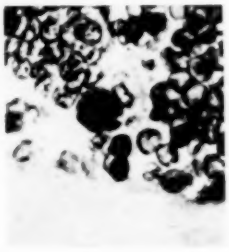

FIG. 28. Photomicrograph taken with high power magnification showing a pigmented macrophage in an ovarian vein (Animal M-4).

our exposures varied in degree, they should be considered as heavy doses. Even the lowest ones resulted in marked degeneration. Degenerative changes were seen in all of the ovaries. The differences to be noted were those of degree, not of kind.

The degree of the degeneration did not depend entirely upon the amount of exposure. Ovaries receiving larger amounts of irradiation sometimes exhibited less degeneration than those which received less treatment. Furthermore, the degree of degeneration was not always proportionate to the length of the interval between treatment and the time that the animal was killed. This difference in sensitivity between animals can be explained on several grounds. The animal's size, the thickness of its tissues, and other circumstances, such as the accuracy of the application of the radium containers, may explain the variations in the degree of degeneration observed. In general, however, the ovaries of the animals which received larger amounts of exposure, and in which longer intervals occurred between treatment and death, exhibited more marked degrees of degeneration. The small amount of our material, however, prevents a proper evaluation of this relationship.

DISCUSSION AND CONCLUSIONS

It is well known that the amount of irradiation and the individual differences in resistance account for variations in biological response of living tissues to this form of treatment. In these respects the albino rat reacts in the same manner as do other experimental animals and human beings.

In considering the observations made in the present study, it must also be remembered that they were made upon the albino rat. We have not yet had the opportunity of making a similar study upon the irradiated *human* ovary, and consequently are unable to state how the findings of the present investigation would compare with the latter.

Brambell and Parkes have stated that the irradiated mouse should be considered as fertile as long as a single oöcyte is present in the ovary. In spite of the presence of histologically normal oöcytes in their ovaries, *our* animals became suddenly or progressively sterile and remained so under prolonged observation. Therefore we conclude that the fertility of the irradiated ovaries depends, not upon the presence of normal-appearing oöcytes in the ovary, but upon their biological condition, which apparently cannot be judged by a study of histologic preparations.

Until recently little has been known regarding the function of the germinal epithelium, except that it is more resistant to irradiation than the oöcytes and the granulosa cells of the follicles. Our material has offered an opportunity to secure further knowledge regarding the biological changes which irradiation causes in this tissue.

We have mentioned above that the formation of normal oöcytes may take place in irradiated ovaries, as long as the germinal epithelium is normal histologically. Murphy has stated that a short

time after irradiation, the oöcytes of an irradiated ovary may be fertilized, and they may give rise to new individuals, which are normal in every respect. This shows that after irradiation, the germinal epithelium for a short time may produce oöcytes that are normal, not only histologically but also biologically. The present study demonstrates that oöcyte formation does not cease with the onset of sterility but germinal epithelium may retain its function of forming oöcytes of normal structure for a long period of time even after severe irradiation. The persistence of this function of the germ layer for a long time after treatment, however, is not exactly identical with oöcyte formation in the normal albino rat.

The differences are (1) of morphological and (2) of biological nature.

(1) Morphological differences between oöcyte formation of normal and of severely irradiated ovaries are easily understood when Hargitt's observations are compared with ours.

(*a*) The faculty of the *irradiated* germinal epithelium to produce oöcytes is less than that of the normal *non-irradiated* epithelium.

(*b*) Irradiated primary follicles develop into secondary ones *less* frequently than do those produced by normal non-irradiated ovaries.

(2) The biological value of the discharged oöcytes is much less than those found in normal ovaries. The ones originating from severely irradiated ovaries seem to lose completely their faculties of becoming fertilized.

It would be a difficult task to give a completely satisfactory explanation of the effect of the radium upon the ovary, especially its influence upon the oöcyte formation. Out of the many possibilities that offer themselves to make this phenomenon intelligible, we have chosen the following one:

Each cell of the germinal epithelium possesses a multitude of factors, the exact natures of which are unknown, but which, taken together, determine the potentialities of the oöcyte. Certain of these factors, which may be termed Group I, concern the process of differentiation of the indifferent germinal epithelial cell into that of the primary oöcyte. A second group aids the primary oöcyte in its transition through all stages of its development, while a third enables it to receive the sperm cell and to give rise to a new individual.

Our experiments indicate that these three groups of factors are not equally radiosensitive. Those which make fertilization possible (Group III) appear to be the most radiosensitive. This phenomenon is indicated by the fact that the irradiated animals become sterile in spite of the persistence of discharging oöcytes.

The second group of factors, the one which brings about the development of the primary follicle to the stage of full maturity, is less radiosensitive than the third group, but more radiosensitive than the first, which is responsible for the differentiation of the oöcyte from the indifferent germinal epithelial cell. This seems the most probable interpretation by which we are enabled to understand what we have seen in our histologic preparations.

The clinical observations collected by one of us (D. P. M.)[17,18] indicated that preconception ovarian irradiation is not harmful to the health or the development of subsequent children. The mating experiment mentioned above gave confirmatory evidence in support of this supposition. The present histologic study, if our reasoning is correct, helps to explain why preconception maternal irradiation is not injurious to the health or the development of subsequent offspring. This is because the factor or group of factors (whichever the case may be) which permit fertilization and further development of the ovum are the ones most sensitive to the influence of irradiation. For this reason although the irradiated germinal epithelium may produce oöcytes, and these may mature, the first injurious effect upon the ovum is interference with the power of fertilization.

SUMMARY

A. Our observations upon the influence of irradiation on the albino rat, though strictly speaking apply only to that animal, will, we believe, closely simulate ones which may in the future be made upon the irradiated human ovary, and consequently for all practical purposes may be considered as such. If this is the case, then the following statements based on the present experimental study have a definite clinical bearing, i.e., in understanding what occurs when the human ovary is subjected to severe radium irradiation.

B. The function of the germinal epithelium of the severely irradiated ovary in certain respects is identical with, and in other respects differs from, that of the non-irradiated ovary.

1. Like the non-irradiated ovary it may be engaged in a continuous process of oöcyte formation. The human ovum fertilized a considerable period of time after irradiation is probably an undifferentiated cell at the time of treatment, a period in its existence when it is probably immune to the amount of irradiation which it receives.
2. It differs from the non-irradiated ovary in at least two ways:
   a. Its oöcyte-producing power is diminished.
   b. Transformation of primary into secondary follicles is less frequent.

C. Oöcytes which have developed from previously irradiated germinal epithelium, and which (oöcytes) histologically appear to be normal, biologically may be incapable of fertilization.

D. Sterility may occur though morphologically normal oöcytes are present.

E. Ovarian degeneration begun by *severe* radium irradiation appears to be a progressive process. Once begun it apparently leads to a complete degeneration, at least as indicated by the appearance of a prolonged, if not a permanent sterility.

F. Of the three factors concerned in (1) the differentiation of the undifferentiated cell of the germ layer into the oöcyte, (2) its growth and (3) its power of becoming fertilized, the last is the *most* radiosensitive. Hence, if preconception ovarian irradiation takes place, and any injury to the growing oöcyte results, its first function to be disordered appears to be that dealing with its power of fertilization. If this supposition is correct we would therefore not expect human preconception ovarian irradiation to be followed by the birth of an infant, injured by reason of the radiation treatment of the ovum before fertilization.

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VARIOUS RADIOPAQUE SUBSTANCES AND THEIR TOXICITY WHEN USED TO VISUALIZE THE RETICULO-ENDOTHELIAL SYSTEM OF LABORATORY ANIMALS*

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WE PREVIOUSLY reported the roentgen visualization of the lymphatic glands and vessels of laboratory animals injected with thorotrast, a colloidal suspension of thorium dioxide.[3] Further studies were undertaken, employing different substances of varying roentgen-ray absorbability rates. We were interested not only in the density of shadow cast by these substances, but also their toxicity. The following media were used: Uranium nitrate, thorotrast, umbrathor, bismuth subcarbonate, bismuth subnitrate, cerium chloride, uroselectan, lipiodol, campiodol, barium sulphate, and brominol. The soluble compounds of these various substances were used in 0.5, 1, 2, 5, 10, and 20 per cent solutions, and the insoluble materials were suspended in water, with and without mucilage of acacia. The halogenated oils used were in an emulsified state, and in one instance we used an unemulsified lipiodol in order to study the collection of this substance in the lymph spaces as reported by Pfahler.[4]

The following methods were employed in administering the various substances: Intracardiac, intravenous (tail vein), intrajugular, subcutaneous, intraperitoneal, and oral. Eighty-eight rats, 3 rabbits, and 3 dogs were used. Roentgenograms were made of each animal immediately after injection, and again at twelve and twenty-four hour periods and in certain instances at much longer intervals of time, except in the case of those which died immediately after being injected.

The absorbability rates of these different substances to the roentgen ray, as presented in Table 1, were obtained from Menville's work.[2]

A very weak solution of uranium nitrate administered intravenously in rats resulted in immediate death. In every instance when this solution came in contact with the blood it caused it to coagulate immediately. In an effort to overcome this, the uranium nitrate solution was diluted with a 2 per cent solution of sodium citrate. This combination

TABLE I

Opaque Medium	*Atomic No. of Element*	*Absorbability of Element*	*Toxicity*
Uranium nitrate	U—92	117887.512	0.003 gm. per kilo intravenously, fatal.
Thorium dioxide (thorotrast; umbrathor)	Th—90	66691.224	Non-toxic, in moderate doses.
Bismuth subcarbonate	Bi—83	46291.045	Non-toxic, in moderate doses.
Bismuth subnitrate	Bi—83	46291.045	Non-toxic, in moderate doses.
Cerium chloride	Ce—58	11057.189	0.05 gm. per kilo intravenously, fatal.
Uroselectan	I—53	6026.432	Non-toxic.
Lipiodol	I—53	6026.432	0.7 c.c. per kilo intravenously, fatal.
Campiodol	I—53	6026.432	Intravenously, fatal.
Barium sulphate	Ba—56	5687.046	Non-toxic.
Brominol	Br—35	1041.329	Death by edema of the lungs if given rapidly or concentrated.

* This work was aided by a grant from the David Trautman-Schwartz Research Fund.

also proved fatal, but death did not occur so rapidly. Roentgenograms made immediately before and after death clearly visualized the heart and blood vessels. The intensity of the shadows produced by uranium was quite marked, and corresponds to the position it occupies as being the first metal in the table of absorbability coefficients.

The subcutaneous injection into the tissues of the rat's tail, of cerium chloride solution, resulted in a marked ulceration, tissue necrosis, and sloughing of the entire tail, but this did not result fatally. Intravenous injection into the tail veins of rats of a weak solution of cerium chloride caused immediate death. Roentgenograms of these rats failed to visualize any of the organs,

Fig. 1. Shows the visualization of the kidneys, liver, spleen, renal and mesenteric vessels after intravenous injection of umbrathor.

Fig. 2. Shows rat injected with barium sulphate subcutaneously, with cyst formation. Note lack of absorption of the barium sulphate by lymph nodes This figure is representative for all the insoluble substances used subcutaneously, with the exception of thorotrast.

due no doubt to the weak solution used.

Umbrathor, the unstabilized colloidal suspension of thorium dioxide, when injected undiluted by the intravenous route proved rapidly fatal. Roentgenograms made immediately after injection revealed most clearly the shadows of the heart, aorta, renal and mesenteric blood vessels (see Fig. 1). When diluted with normal saline, we were able to visualize the blood vessels, liver and spleen, without harmful effect to the animals.

In the instances in which we used barium and bismuth salts, injected subcutaneously, very good shadows were obtained, but these substances were not absorbed; they

remained at, or near, the site of injection, with encapsulation, and apparent cyst formation (Fig. 2). The halogenated oils, campiodol, brominol, and lipiodol, were used in our experiments, both intravenously and subcutaneously, without evidence of being absorbed by the lymphatics. Brominol was employed according to the technique of Keith and Briggs[1] and faint shadows of the liver and spleen were observed. Visualization of the lymphatic glands was not observed with any of the substances used, with the exception of thorotrast.

CONCLUSIONS

1. The soluble compounds containing elements which show greater or lesser absorption to the roentgen ray than thorotrast are very toxic. The insoluble compounds used contain particles too large to be phagocytized by the reticulo-endothelial system.

2. Lipiodol collects in the tissue lymphatic spaces, but does not reach the lymph nodes.

3. The intensity of the shadows cast by the various substances corresponds to the absorbability coefficients, for uranium nitrate and for brominol.

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THE INJECTION OF LIPIODOL INTO THE KNEE JOINT*

A WARNING AGAINST ITS USE

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REVIEW OF LITERATURE

KOBES and Militzer, in 1927, noted that the absorption and excretion of iodipin (40 per cent iodine) injected intra-articularly was much slower than when it was injected subcutaneously or intramuscularly, taking about 490 days for its total excretion. In their experimental animals, iodipin caused no joint damage. The capsule and cartilage lining, soon after injection, was seen to be smooth on gross and microscopic examination. Fat, derived from the splitting up of the iodipin into fat and free iodine, was seen in the superficial layers of the synovia and cartilage, lessening in amount in the deeper layers, and least at the chondro-osseous junction. The menisci showed a fatty infiltration superficially. The injections were noted to be harmless, both in their experimental and clinical work. A leucocytosis was observed in children two to three hours after injection, persisting for about a day. A more permanent lymphocytosis, lasting about a month, was also noted, a change which they considered of value in the treatment of joint tuberculosis. Crandall and Walsh, in 1929, on the basis of a few animal experiments (2 c.c. of lipiodol or lipoiodin were injected into the right knee and right shoulder joint of 3 animals) believed that the injection of lipiodol intra-articularly was not entirely harmless, although slight reaction was experienced. The animals showed no joint symptoms. About 1 to 2 c.c. of an oily fluid, made up of injected oil, fibrin, leucocytes, and a mucin-like material, were noticed on opening the joints, twenty-two and twenty-six days later. The joint was sterile. The cartilage lining was uninjured. A thin membrane, containing some fibrin and oil droplets, covered the capsule in part, a membrane similar to one obtained by the injection of lipiodol into the pericardial and pleural sacs. It was thought that the amount of motion of the serous membranes might be an index to the chemical damage done, most in the pericardial sac (pericarditis with effusion), less in the joint cavity, and none in the peritoneal cavity. Sigurdson also believed the experimental intra-articular injection of lipiodol to be harmless, from a study of 4 rabbits examined periodically until death of the animal, sixty-six to ninety-eight hours after the injection of the lipiodol into the knee joint. He judged from his roentgenograms that a period of at least four days was necessary for the complete disappearance of the lipiodol from the joint, by a slow diffusion of the oil through the entire capsule. This diffusion was accentuated by pressure changes in the joint as a result of joint movement. Lymphatic absorption was slight. After leaving the joint, most of the oil gravitated downward to the region of the tibio-tarsal joint, though in one rabbit, the oil moved upward towards the hip joint. Examination of the injected joints showed no infection in any. Microscopically, his findings were similar to those of Kobes and Militzer, though at about ninety-eight hours after injection most of the oil had disappeared from the capsule.

Borak and Goldhamer preferred iodipin to potassium or sodium iodide in arthrography, because of the fact that iodipin had a slower power of extension through the joint, and because there was no reflux of oil.

Clinically, little doubt has been voiced

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FIG. 1. Roentgenogram taken shortly after the injection of 15 c.c. of lipiodol into the knee joint. Note droplet formation in the quadriceps bursa, indicating hydrops bursae. One week before injection, 40 c.c. of a serous fluid had been aspirated. The crusting of the femoral condyles by the oil is shown.

on the relative harmlessness of lipiodol or iodipin injected intra-articularly. Sicard and Forestier, in 1923, injected the hip of an elderly man, afflicted with arthritis, with lipiodol. They noted in the legend beneath the drawing of the roentgenogram (not in the text) that the patient had much pain after the injection and was in bed for three to four days. However, the patient obtained much relief later. Sievers, in 1926, injected the congenitally dislocated hips of children with iodipin, with special reference to its value in determining manipulative reposition and retention of the hip. He believed the injections to be harmless, though in a later paper he became more cautious, saying that the harmlessness of iodipin injected into joints was not completely proved. Simon, in discussing Sievers' later paper, stressed the fact that one could not be sure of the harmlessness of these injections.

Bettmann has injected 20 per cent iodipin combined with 2 per cent psikain (Merck) in the intra-articular therapy of arthritis. The oil, he thought, acted as a mechanical buffer, with biological qualities. Some pain was experienced about six hours after injection and therefore he kept the injected joint at rest for about a day. The slow splitting off of iodine with comparative freedom from iodism, the gradual absorption of the oil within a period of months, and its ability to check the formation of adhesions (a fact pointed out by Rehn in experimental, intrapericardial injections of iodipin), all favored its use in such therapy. He also used iodipin in the treatment of tuberculous and luetic joints. He believed his results encouraging, though he had followed his cases for only a short period of time. More recently, he formulated the technique of his injections, with special reference to tuberculosis of bones and joints, especially with contractures. In spastic contractures, he injected the iodipin directly into the muscle mass, with subsequent release of the contracture. Kreuscher and Kelikian (1930) have begun the use of lipiodol and iodipin injected intra-articularly in the diagnosis and treatment of joint lesions (the knee joint injected in 7 cases and the hip joint in 3 cases). One patient was operated on five days after the injection, a synovectomy of the knee being done. Much of the iodized oil was free in the joint, though microscopically, fat droplets were seen adherent to the surface of the joint, and also were present in the intercellular spaces of the connective tissue beneath the synovial lining. The lymphatics contained some fat

droplets. They believed the injection of lipiodol intra-articularly valuable both from a diagnostic and a therapeutic standpoint. Freedom of motion of the joint and relief of pain were reported by their patients. No pain or any reaction was observed following the injection, even when 100 c.c. of lipiodol was injected.

Knoll and Matthies (1931), on the basis of some cadaver experiments, believe iodipin suitable for joint visualization. No clinical work was done.

Note should also be made of the work of Keller. He injected 25 to 30 c.c. of a 10 per cent solution of the neutral sodium salt of tetra-iodo-ortho-sulphobenzoic acid into the knee joints of his selected cases, an excellent radiopaque shadow being obtained. This is a new drug, synthetically prepared by Twiss and investigated pharmacologically by Macht. Keller does note a mild reaction in some cases, setting in a few hours after injection and subsiding rapidly.

THE INJECTION OF LIPIODOL INTRA-ARTICULARLY

A Study of Thirteen Patients

The intra-articular injection of an iodized oil is considered harmless, as a detailed study of the literature indicates. This study was undertaken because we thought the method good, not only diagnostically but also therapeutically. Since the method was considered free from danger, the patients were all injected within a period of two weeks, in the Out-Patient Department of the Hospital for Joint Diseases, and not hospitalized. As soon as the dangers of the procedure were recognized, the injections were discontinued. This report is a *warning* against the use of lipiodol injected intra-articularly.

We injected lipiodol into the knee joints of 13 patients. The age of the patients, 6 men and 7 women, varied from thirty-four to sixty-one. Twelve of the 13 suffered from arthritis of the knee, mild to severe, over a period ranging from two months to three years. The thirteenth patient, a man, was diagnosed as having a bursitis under the insertion of the biceps femoris tendon, and was used as a normal control joint. Only 2 cases showed marked bone changes roentgraphically, marked narrowing of the interarticular space with irregularity, indicating definite bony and cartilaginous destruction. In one case, a man of sixty-one, a sterile effusion of the knee was tapped,

FIG. 2*a*. Roentgenogram taken shortly after the injection of 10 c.c. of lipiodol. Note irregularity of the quadriceps bursa. The outline of the inner meniscus is well shown, the posterior border showing up more distinctly. The outer meniscus shows poorly. Site of injection of oil seen externally.

40 c.c. of a light brown fluid, with some fibrin in it, being obtained. Most patients complained of pain in and about the knee joint, swelling of moderate degree, and crepitation on motion. Motion usually was almost normal. In 3 cases, extension was slightly limited to 170° of extension, and flexion was definitely lessened, even up to 90° of flexion. Practically all cases showed enlargement of the infrapatellar fat pad and hypertrophy of the synovial membrane. In one case, a foreign body was seen in the roentgenogram, in a woman with a moderate arthritis of the knee, with definite limitation of motion.

FIG. 2*b*. Lateral roentgenogram of the same knee taken three days after injection. Observe the oil in the soft tissues of the leg posteriorly and in the popliteal bursa. The oil covers the condyles both as a crust and in delicate curvilinear lines.

TECHNIQUE

Under local anesthesia (novocaine), 10 c.c. of undiluted lipiodol (in a few cases, a little more) was injected into the knee joint. The injection of the fluid was given slowly and necessarily with some force, because of the high viscosity of the oil. It was best to give the oil, previously sterilized, while warm, the flow being easier. No pain was experienced during the entrance of the oil into the joint, though a sense of fullness or pressure was complained of. Reflux of oil through the puncture wound was seen in 2 cases. In 2 cases, the lipiodol was diluted with sterile olive oil, to test out light lipiodol in comparison with heavy lipiodol. Only one patient experienced a reaction during injection, a diffuse, scarlatiniform blush, spreading and disappearing rapidly over the face, a not unusual phenomenon with the patient in moments of pain or stress. Stereoscopic roentgenograms of the injected knee were then taken in some, though in most, simple anteroposterior and lateral views were taken, the knee having been at rest or in motion. The patient was then sent home, advised to stay in bed, and to note any particular reaction. Many of the patients were seen at home because of the particular reaction to be described. Roentgenograms were taken periodically and the patients examined frequently.

REACTION OF THE JOINT TO LIPIODOL

About three hours after the injection, the patients all were seized with severe, knife-like pains in the knee joint, radiating up the thigh and down the leg. Sleep was impossible, the pain being barely endurable in many cases. The acute pain lasted for about twelve hours, then gradually abated, and in a duller, gradually lessening form, persisted for two to eleven days. The tolerance to pain varied naturally with the make-up of the patient. With the pain, the signs of a chemical synovitis of varying degree, mild to severe, were noted—swelling of the joint, local heat, diffuse tenderness of the joint, and refusal to move the joint because of pain and stiffness. No redness was present. The chemical synovitis, apart from the severity of the pain, lasted from one to two weeks. As a rule, there were no general symptoms, though one

patient did have a moderate rise in temperature, and another complained of faintness and vomiting. The patient was confined to bed. With the lessening of the pain and the gradual clearing up of the synovitis, the patient limped in walking, using a cane as a support.

The uniform severity of the immediate reaction is apparently not mentioned in the experience of others. A painful reaction is occasionally mentioned. It should not be forgotten that the general impression holds true, and with reason, that the injection of lipiodol into any body cavity is harmless.

MORE REMOTE RESULTS

The reaction to lipiodol, as has been noted, lasted from two to eleven days. There was then a gradual improvement in 4 cases, even up to the point of "wonderful relief." In one woman, with an advanced arthritis of the knee, with alteration of the plane of the knee joint due to an old fracture of the upper end of the tibia, with marked pain and swelling of the knee, and definite limitation of motion, marked improvement in her symptoms was noted ten days after the injection, despite the reaction. Of the other 3 cases, one was definitely sure that he was better symptomatically, and the other two admitted some improvement. Objectively, the knees were unchanged. Two patients did not return to the clinic. (One of these was seen sixteen months later, her condition being unchanged.) The patient with the bursitis beneath the insertion of the biceps femoris tendon was brought into the clinic by a social worker and proved a most unusual case. He had been in bed for two weeks, and in the second week of his illness had had chiropractic manipulations of his knee. Examination of the knee disclosed a mass posteriorly, arising from the inner femoral condyle, and following the course of the inner head of the gastrocnemius muscle for about 4 inches. The mass was oval in shape, about $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches wide, tender, moderately warm, and did not interfere with the motions of the knee joint. The severity of the chiropractic manipulations had forced all the lipiodol through the capsule into the inner head of the gastrocnemius, where it formed this well-defined mass. A roentgenogram confirmed the diagnosis. The further course of the tumor could not be followed since the patient was seen only once again.

Fig. 3. Lateral roentgenogram taken shortly after injection of 5 c.c. of lipiodol and 7 c.c. of olive oil mixed together. The filling defect in the quadriceps bursa persisted in succeeding plates.

One patient had a para-articular injec-

tion and does not properly belong in the consideration of end-results. The remaining 5 cases, observed for a period of several months, showed no improvement. Two said the injection had made them worse. This was verified objectively in one man,

FIG. 4. Roentgenogram taken seventeen days after injection of 10 c.c. of lipiodol in a man with bursitis under the insertion of the biceps femoris tendon. The bursa itself did not fill. The lipiodol is massed in the inner head of the gastrocnemius, where it formed a definitely palpable mass.

in a definite restriction of motion, not present before injection, increased crepitation, and greater swelling of the knee. Objective examination of the knee joints of the other 4 showed no demonstrable change.

Some of the patients received routine baking and massage treatments a few weeks after the injection.

Four patients were seen sixteen months after injection. Three of these were strenuous in condemning the use of lipiodol; the fourth, a man who had originally admitted improvement, believed the lipiodol had benefited him.

A study of the synovial fluid was not made, though undoubtedly a study of the fluid during the period of reaction would have been very valuable.

ROENTGENOLOGIC FINDINGS (ARTHROGRAPHY OF THE KNEE JOINT)

It may be repeated with Kreuscher and Kelikian that patchy distribution of lipiodol indicates synovial pathology, such as adhesions, hypertrophy, etc. In our one normal knee, the distribution of lipiodol was regular, the amount of filling up of the various spaces naturally depending on the amount of oil injected. The bursa involved did not fill up. If too much oil is injected, detail is obscured and barest outline seen. Ten to 15 c.c. is enough for diagnostic purposes and definitely too much for therapeutic work. The immediate shadow seen after injection is much too dense for fine interpretation. Plates are best read when taken two to three days after injection, at which time the oil has dispersed itself more uniformly. Light lipiodol also gives a less dense shadow, but with not so much detail.

We do not believe that the amount of oil one can inject is a true and final index of the capacity of the joint. The oil may not be able to penetrate partially adherent and sacculated spaces, into which a serous fluid may easily go. It is not important to determine the capacity of the joint by injecting lipiodol into it.

Most of the lipiodol enters the quadriceps bursa, especially in the extended position. Irregularities, deformities, notchings of the bursa are usually noticed in arthritic knees. In a few cases, definite filling defects in the bursa, outlined in the first plate, have persisted in the series of plates taken at periodic intervals. The oil is not uniformly distributed throughout the bursa, being more dense and uniform externally, and more spotty elsewhere in distribution. The bursa may be smooth and rounded at its apex, or peaked or truncated. In

no case was the bursa bipartite. In the presence of hydrops of the bursa, even of slight or moderate degree, the fat droplets, resulting from the admixture of oil and water, are well seen as rounded, small to moderate-sized, discrete drops (droplet formation), much as in the injection of lipiodol in a hydrosalpinx. This was noted in 2 cases, and did not persist in the succeeding roentgenograms. In all cases, the bursa communicated with the joint proper, though in one case, adhesions in the bursa partially prevented the oil from leaving the bursa; in another, an adhesion allowed the oil to leave the bursa only externally. The bursa, in several cases, was not in contact with the femur throughout, being separated from it by an appreciable space at its upper part. No attempt was made to determine the full measurements of the bursa since this has been done well by Colp and Klingenstein in their sodium iodide injections. As time passes, the bursa fills up more evenly as regards density. It is the last place from which the oil leaves the joint, and sixteen months after injection, the oil shadows may still be seen in the bursa. With motion of the knee, the pumping action of the knee tended to force some of the lipiodol into the posterior compartment of the knee.

The shadows of the menisci are best seen soon after injection, the inner meniscus always being better outlined than the outer. As determined by stereoscopic examination, it is the posterior border of the meniscus which is best recorded in its density. The anterior rim appears as a faint shadow, continuous with the posterior border. This may be due to the fact that the oil gravitates posteriorly in the anteroposterior position. No detail of their structure is visible, only their barest outlines. The outlines of the menisci are not well seen after a week, since the oil breaks up into fine granules, which disperse easily. How much value there is in seeing the outline of the menisci we cannot say.

In many cases, the lipiodol forms a crust over the femoral condyles, well seen in stereoscopic lateral views. It is poorly seen over the tibial condyles. Again, the deposition of the lipiodol over the cartilage may show itself linearly, following the curve of the condyles, in much the same fashion that a non-opaque calculus in the gallbladder is rendered visible by the injection or ingestion of tetraiodophenolphthalein. The lipiodol coating may be noted for several months.

Fig. 5. Roentgenogram taken sixteen months after injection of about 10 c.c. of lipiodol. Note the amount of oil still present within the joint.

In cases of advanced arthritis, no lipiodol may be seen in the joint proper, save a little at the site of injection. All the lipiodol may be in the quadriceps bursa or posteriorly.

No detail is usually seen in the region of the tibial spines or intercondyloid notch,

only a blurred mass of lipiodol being noted there. In no case were the crucial ligaments visualized. The internal lateral ligament was visualized in one case by a deposition of oil alongside it. Communication with the posterior bursa was not often seen. The popliteal bursa was seldom well outlined. Lines of adhesion in the joint may be outlined. The point of injection of the lipiodol is usually seen. A shadow of a foreign body was not visualized in the one case where it was present, the shadow of the lipiodol being denser than that of the body. No cavitations in bone were seen.

There may be a rapid exit of the lipiodol from the joint cavity even as early as three days after injection. Dispersion here takes place through the capsule, possibly uniformly, most probably not, and along intermuscular and interfasicular planes, either of the posterior part of the thigh or leg. The oil may sweep over the soft tissues externally, in the region of the head of the fibula. The final disposal of lipiodol then becomes a matter of time. Oil may also be seen in muscle tissue, usually in the inner head of the gastrocnemius. We have seen this three times, best in the case previously detailed. In other cases, there may be a gradual absorption of the oil, with lessening of density of the lipiodol shadow. The oil is not in the soft tissues about the joint, but its shadow gradually disappears. Most probably there is slow and continuous absorption, possibly by lymphatics. In general, it takes about three months to rid the joint of most of its lipiodol, by whatever method of disposal concerned. It is possible that the time of duration of absorption may be much longer than noted here. Of the 4 patients who were seen sixteen months after injection, 2 were roentgenographed. In both, lipiodol was still present in the joint, slight in one and marked in the other. One can only postulate on the functional integrity of the capsule in its relation to absorption of lipiodol in arthritic knees. In the one case in which the oil was injected para-articularly, the shadow of the oil, gradually breaking up, was still noticed strongly at two months.

POSSIBLE COMPLICATIONS AND SEQUELAE

The danger of infecting the knee joint by injecting lipiodol into it is apparently slight. Adhesions may form in the joint because of the irritating action of the oil, and we believe this to have happened in one of our cases. The chemical synovitis has already been described. It is a possibility that any droplet of residual oil may become the core of a future calculus. This has happened in the Fallopian tube (Albano). Encystment of the oil and oil tumor are far-fetched possibilities.

CONCLUSION

It cannot be too strongly emphasized that the intra-articular injection of lipiodol is a dangerous procedure. *It should never be used intra-articularly.*

We wish to thank Drs. Paul Lapidus and David Kling and Mr. Joseph Duran for their helpful assistance in the course of this work. May we also thank Dr. Leo Mayer for his helpful criticism.

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THE TRACHEA IN NON-SYPHILITIC DISEASE OF THE ASCENDING AORTA AND THE AORTIC ARCH*

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I WISH to emphasize the alterations in the position and configuration of the tracheal silhouette in non-syphilitic disease of the aorta and the mechanism whereby

FIG. 1. Case I. Roentgenogram of chest in antero-posterior position. *Lungs*—Moderate dilatation of secondary pulmonic vessels. *Heart*—Horizontal, left ventricle definitely rounded. Some elongation of ascending limb of aorta with prominence of aortic arch. Slight dilatation of descending limb. Displacement of trachea to right.

these changes are brought about. Normally the tracheal silhouette is visualized in the midline, the bifurcation being at the level of the fourth thoracic vertebra. Occasionally there is slight deviation of the "air space" to either side.

In disease of the thoracic structures there is often a change in the position and configuration of the tracheal shadow. This is either due to traction in pathological states, where there is considerable fibrous tissue replacement (chronic tuberculosis; chronic non-tuberculous pleuropneumonia, certain types of bronchial carcinoma; chronic pleurisy; syphilis) or displacement in instances of disturbed intrathoracic pressure (pleural effusion; pneumothorax; bronchial stenosis; tumors of the lung; bronchus; pleura; thyroid; thymus, etc.[6]). However all these conditions are beyond the scope of this communication.

For the sake of brevity this presentation will be limited to the consideration of a few typical, illustrative cases.

Group 1.

Deviation of the Trachea to the Right.

CASE I. A. S., a very neurotic male, aged forty-one, was admitted to the Montefiore Hospital on February 27, 1931, with a history of measles, mumps, pertussis, diphtheria, and scarlet fever in childhood and frequent sore throats subsequently. The complaints on admission were attacks of palpitation for the past seven years, and headaches, dizziness and nervousness for the past year.

Physical examination showed enlargement of mediastinal dullness to the left, accentuation of A2, hyperreflexia, and a blood pressure of 210/120. Fundus examination revealed spasms, constrictions, and narrowing of the arteries. No hemorrhages or exudates. Urine was negative, blood Wassermann was negative, blood chemistry was normal. Electrocardiogram showed left axis deviation and paroxysmal auricular tachycardia.

Course in Hospital. Following the excision of a mandibular cyst, the patient developed an attack of paroxysmal auricular tachycardia which responded well to sedatives and tr. digitalis. Discharged on May 24, 1931, considerably improved.

Diagnosis. Essential hypertension, cardiac enlargement, paroxysmal auricular tachycardia.

CASE II. C. B., female, aged seventy-three, was admitted to the Montefiore Hospital on February 9, 1927, with a history of attacks of upper abdominal pain unrelated to meals, for four years, progressive weakness for three years, tremor of right arm and leg for two years.

Physical examination showed chronic arthritis, manifestations of paralysis agitans, enlargement of mediastinal dullness to the left, marked pulsation in the suprasternal notch, systolic murmur over the aortic area with an accentuated A2, and a soft systolic blow over the mitral area. Fundus examination showed marked narrowing and tortuosity of the arteries. Blood pressure was 190/80. Urine showed presence of albumin at times with numerous white blood cells and occasional red blood cells. Concentration test 1.012–1.026. Blood Wassermann was negative, blood chemistry was normal. Electrocardiogram showed left axis deviation.

Course in Hospital. Patient was bed-ridden during her entire stay in the hospital. On May 7, 1931, a rise in temperature, increase in pulse rate, generalized dullness, diminished breathing and râles at the bases, were noted. Two weeks later a pericardial friction rub developed and patient expired on May 22, 1931.

Diagnosis. Generalized atherosclerosis, cerebral artherosclerosis, paralysis agitans, chronic arthritis, bronchopneumonia, fibrinous pericarditis.

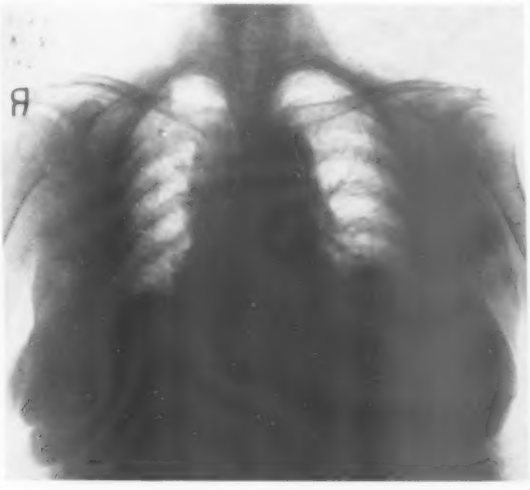

Fig. 2. Case II. Roentgenogram of chest in antero-posterior position. *Heart*—Normal in size and shape but median in position. Marked widening of superior mediastinum especially to right, suggestive of mediastinal neoplasm. A roentgenogram taken three weeks later revealed no evidence of pulmonary metastases, but enlargement of nodes at the hilus, possibly metastatic. Both plates show tracheal deviation to the right. *Lungs*—Thickening of pleura at right apex.

Autopsy. Some of the pertinent findings were marked atherosclerosis and ectasia of the ascending aorta and aortic arch, bronchopneumonia, fibrinous pericarditis.

Fig. 3. Case III. Roentgenogram of chest in antero-posterior position. *Lungs*—Pleural thickening in right costophrenic angle with partial fixation of diaphragm. *Heart*—Left ventricle moderately rounded and prominent. Ascending limb of aorta elongated and tortuous. Arch prominent and dilated. Trachea displaced to right. (Note the slight overlapping by aortic arch.)

Of particular interest here is the roentgen diagnosis of possible neoplasm of the superior mediastinum.

Case III. E. K., a medical missionary, aged fifty-six, was admitted to the Montefiore Hospital on February 9, 1931. His illness began sixteen months prior to admission with a sudden attack of severe dyspnea and precordial pain. Since then he suffered constant dyspnea and precordial pain.

Physical examination showed an emphysematous type of chest, heart sounds distant, liver edge 2 fingers below costal margin, râles and dullness at the bases. Blood pressure was 130/80. Urine and blood Wassermann were negative; blood chemistry was normal. Electrocardiogram showed left axis deviation.

Course in Hospital. Patient received paravertebral block on February 19 and March 23 with some relief from anginal seizures. Discharged improved on March 29, 1931.

Fig. 4. Case iv. Roentgenogram of chest in antero-posterior position. *Lungs*—Retraction and pleural thickening and adhesions in left costophrenic angle. Diaphragmatic adhesion on right. *Heart*—Globular, left ventricle prominent and rounded, moderate horizontal enlargement of left auricle (roentgenoscopy in right and left oblique positions), first portion of ascending aorta shows circumscribed dilatation with marked tortuosity and elongation. Calcification in arch. Trachea displaced to right by ascending aorta.

Diagnosis. Coronary artery disease with myocardial infarctions.

Case iv. G. N., male, aged sixty-four, was first admitted to Montefiore Hospital on January 30, 1930, with a history of Neisserian and syphilitic infections in his youth. Dyspnea and fatigue on slight exertion had been present for two years, nocturnal cough for one year. Discharged on October 22, 1930. Readmitted on April 24, 1931, with manifestations of marked cardiac insufficiency, cyanosis of lips, ears, nose, Cheyne-Stokes breathing, scarcely audible heart sounds, congestion at the bases, enlargement of the liver and marked edema of the legs and scrotum. Blood pressure was 118/60. Urine was negative. Blood and spinal Wassermann were negative, blood chemistry was normal. Electrocardiogram showed left axis deviation.

Course in Hospital. Patient expired a few hours after admission.

Diagnosis. Hypertensive cardiovascular disease with atherosclerosis, coronary artery disease with multiple myocardial infarctions, cardiac insufficiency.

Autopsy. Some of the pertinent findings were generalized atherosclerosis, cardiac hypertrophy and dilatation, atherosclerosis of kidneys, atherosclerosis of coronary arteries with numerous occlusions, atheromatosis of ascending aorta and aortic arch, no evidence of syphilis.

Group 2.

Overlapping of Trachea by the Aorta.

Case v. I. D., male, aged forty-four, was admitted to the Montefiore Hospital on February 7, 1931, with a history of fever, and pain in the shoulder and knee joints two years prior to admission. In September, 1931, he suffered an attack of precordial pain for which he required hospitalization. While in the hospital patient complained of dyspnea, precordial pain, occasional headaches.

Physical examination showed increased mediastinal dullness to the left, A2 markedly accentuated, bilateral positive Murphy sign, right testicle symmetrically moderately enlarged, the left atrophic, prostatic enlargement. Urine was positive for albumin, and showed many red blood cells and white blood cells with granular casts. Blood chemistry was normal; blood Wassermann was negative. Electrocardiogram showed left axis deviation.

Course in Hospital. On the medical service patient continuously complained of precordial

Fig. 5. Case v. Roentgenogram of chest in antero-posterior position. *Lungs*—Somewhat increased markings. *Heart*—Enlarged, rounding of left ventricle, prominence of aortic arch. Note the overlapping of trachea by aorta.

and joint pains. Vesiculectomy was performed on April 8, 1931. Discharged on June 3, 1931, improved.

Diagnosis. Atherosclerotic cardiovascular disease, coronary artery disease.

DISCUSSION

Curschmann,[2] in 1905, in describing 2 cases of syphilitic aortitis, one apparently associated with aneurysmal dilatation of the aorta, noted marked deviation of the trachea to the right on physical examination and suggested as the etiological factor widening of the ascending aorta and the aortic arch. Pfeiffer[5] in 1906 corroborated these findings and advocated the utilization of the roentgen ray as preferable to physical examination in determining the position of the trachea in pathological states involving the thoracic organs. As far as could be determined, there is no mention of an alteration in the position and configuration of the tracheal silhouette in non-syphilitic disease of the aorta.

From the intimate relationship of the lower portion of the trachea to the ascending aorta and aortic arch (Fig. 6) it is readily conceivable that factors causing widening, elongation, and tortuosity of this vessel will affect the tracheal silhouette. This may manifest itself in any one of three ways: (1) The trachea may be pushed posteriorly at the bifurcation so that the upper portion is forced anteriorly.[4] This anterior posterior displacement is not demonstrable by the usual roentgenograms. (2) The trachea may be deviated to the right (Cases I, II, III and IV). (3) The trachea may be overlapped by the aorta and its configuration altered at the site of overlapping (Case V). Of these the deviation of the trachea to the right is by far the most frequent.

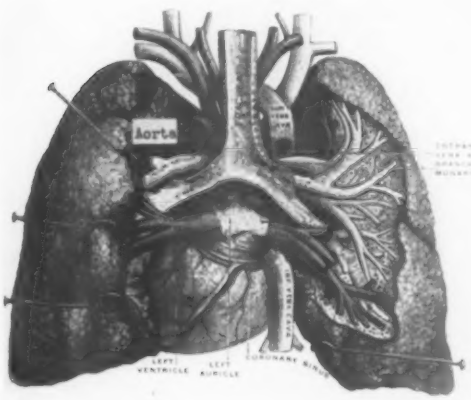

FIG. 6. Posterior view of thoracic structures showing the intimate relationship of the trachea to the ascending aorta and the aortic arch. (Gray's Anatomy.)

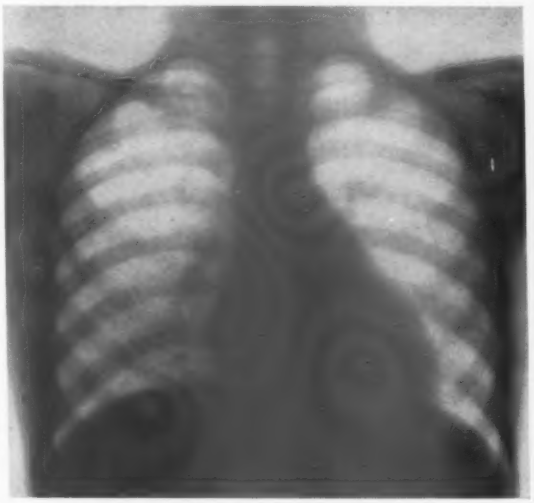

FIG. 7. Roentgenogram of chest in anteroposterior position. Note the eparterial bronchus.

These alterations in the position and configuration of the tracheal silhouette have been observed in the following conditions: (1) hypertension present or antecedent; (2) atherosclerosis; (3) senile ectasia. Of course, in many instances in which these factors are present the trachea is in the mid-line and its configuration unaltered. Perhaps here the displacement is in an anteroposterior direction.

In determining the alteration in position and configuration of the tracheal silhouette it is important to emphasize certain possible sources of error, namely:

(1) The patient must be standing absolutely straight, the criteria for this being the configuration of the vertebral column, the position of the sternoclavicular joints, and the level of the scapulae. (In Case IV

the deviation of the trachea to the right is so marked that the slight tilting of the neck to the left may be disregarded.)

(2) All pathological processes of the thoracic organs causing traction or displacement must be eliminated.

(3) Caution must be exercised in not mistaking the eparterial bronchus for this phenomenon (Fig. 7).

(4) The marked enlargement of the left auricle seen particularly in chronic rheumatic cardiovalvular disease frequently causes a greater obtuse angle of the tracheal bifurcation or compresses the left main bronchus and must always be eliminated as a possible factor in distortion of the tracheal silhouette (the left oblique position is important here).

CONCLUSIONS

1. Pathological-physiological changes in the supraventricular portion of the aorta and the aortic arch may cause widening, elongation, and tortuosity of the aorta.

2. Because of the intimate anatomical relationship of this portion of the aorta to the trachea there is frequently an alteration in the position and configuration of the tracheal silhouette. In order of demonstrable frequency of their occurrence these alterations are (*a*) deviation of the trachea to the right, (*b*) overlapping of the trachea by the aorta.

3. In one instance (Case II) the roentgenological diagnosis of superior mediastinal neoplasm was suspected but at autopsy atherosclerosis and ectasia of the aorta and aortic arch with deviation of the trachea to the right were found.

I wish to express my gratitude to Dr. G. Nemet for his kind suggestions in the preparation of this paper.

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URETHRAL CALCULI

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CALCULI seldom lodge within the male urethra, there being but 7 in a series of 2,900 urological cases reported by LeComte.[3] Such arrest of a calculus passing from a higher point in the urinary tract is influenced by inflammatory or traumatic changes within the urethra. Normally, the urethral caliber is sufficiently large to permit evacuation of such calculi. The most frequent cause of arrest in passage is inflammatory stricture, although the passage may be blocked at other points than posterior to a strictured area.

Urethral calculi are classified as primary, those originating in the canal proper, and secondary, those which are arrested in the canal after formation elsewhere in the urinary tract.

The primary type is quite rare, especially in the female. Their presence will generally be indicated by the signs of local irritation and interference with the urinary stream. There are no symptoms[5] referable to the upper urinary tract. Developing in an irregular canal or pocket, their symptoms will be of gradual onset and not necessarily characteristic.

Fig. 1. Anteroposterior view of penis showing calculus.

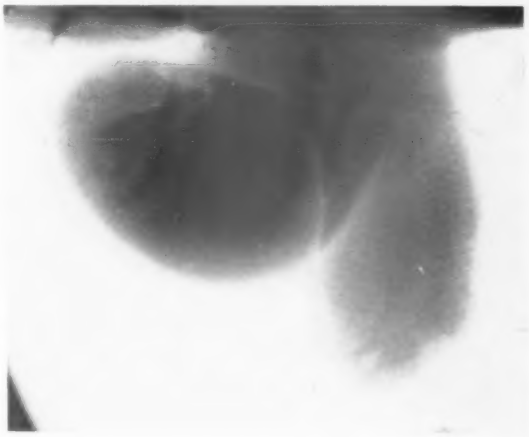

Fig. 2. Lateral view of penis showing calculus.

In the secondary type, there will ordinarily be a history suggestive of calculus higher up in the urinary tract with supervention of symptoms due to local changes within the urethra. These may be present as (1) the urethral type, lying entirely within the urethra; (2) vesico-urethral type, lying partly in the bladder and partly in the urethra, and (3) prostato-urethral, originating in the prostate and projecting into the urethra.[4]

The sites of predilection are the prostatic and membranous portions of the urethra, and multiple calculi are not infrequently met with, Civiale[2] reporting 230 in one case. Their size is quite variable, weights as large as 390 grams having been reported.

Obstruction, partial or complete, is the universal symptom. Infection soon develops with its added evidence of local urethral irritation. Such infection may lead to subsequent prostatitis or prostatic abscess and peri-urethral inflammation with or without extravasation and fistula formation. Hemorrhage may be present.

Fig. 3. Photograph of calculus (enlarged).

Calculi large enough to lodge within the canal can usually be palpated genitally or rectally. The grating click obtained on the passage of a metal sound is of positive diagnostic value. They may frequently be observed through the urethroscope. The roentgen ray has been little used for diagnosis but is of undoubted value either as unaided roentgenography or by urethrograms, especially where calculi are lodged at the vesical orifice in such a manner as to prevent instrumental examination. Cassuto[1] reports 4 cases in which urethrography with lipiodol confirmed a doubtful diagnosis.

Treatment should be of the simplest possible type necessary to effect removal. It will require variation to meet the particular case and may range from meatotomy to perineal section.

The following case is reported:

L. G., white male, aged forty. About two years ago he had suffered a series of attacks of kidney colic on the right, culminating in the passage of four calculi one year later. Subsequently, there were no symptoms for a period of about one year and on May 24, 1932, he first noticed difficulty in urination, manifested by delay in starting with a small dribbling, scattered stream. There was no associated pain or other symptoms. The following day he consulted Dr. W. G. Eberle, through whose courtesy this case is reported, who found the calculus on palpation and determined that it lay posterior to an inflammatory stricture in the membranous urethra. He was referred for roentgen examination which confirmed the diagnosis (Figs. 1 and 2). Urethroscopic examination demonstrated the calculus and by manipulation through the instrument, the calculus was dislodged from its imbedded position in the urethral wall. The urethra was then distended and with release of the distention, the patient passed the calculus (Fig. 3). A flat roentgenogram of the urinary tract did not demonstrate shadows of other calculi. The subsequent progress was uneventful.

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GALLSTONES CONFUSED WITH COLON DIVERTICULA

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THE roentgenogram shown in Figure 1 was made preliminary to a barium study of the stomach. Note the small ring shadows in the subhepatic region quite suggestive of gallstones both from their position and appearance.

On the following day the ingested barium had largely passed from the bowel and a series of films was made again through the gallbladder region. Figure 2 shows an average roentgenogram. The shadows are more visible than before and have all the appearances of colon diverticula. A secondary filling of the colon shows numerous diverticula in this region although they were absent in remaining segments of the bowel (see Fig. 3).

About two weeks before the roentgen ex-

Fig. 1. A roentgenogram from a preliminary plain series through the gallbladder region. The shadows simulate gallstones because of location and peripheral density.

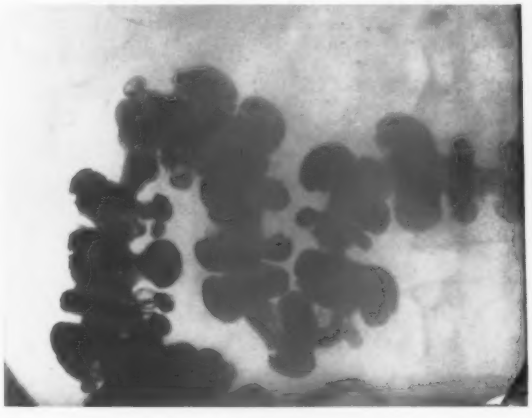

Fig. 3. A second barium meal shows at nine hours numerous typical diverticula in the hepatic region only. This verified the inference of diverticula simulating gallstones.

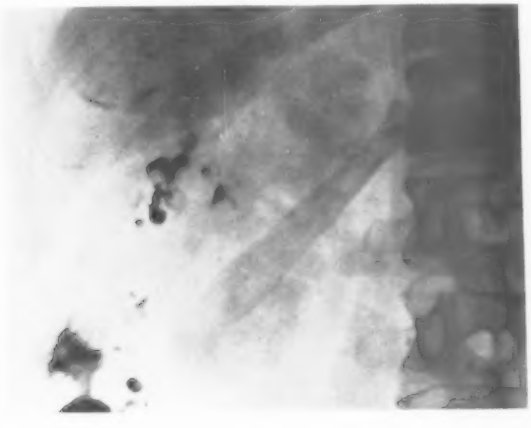

Fig. 2. Twenty-four hours after a barium meal the slight regional residue strongly suggests diverticula, some of which show an increased peripheral density as from barium coating of the walls.

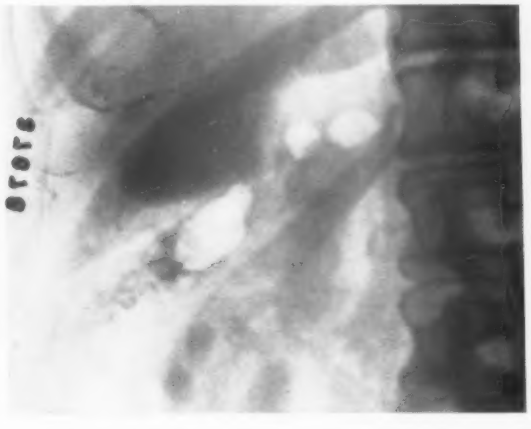

Fig. 4. One of a dye series visualizing the gallbladder two weeks before our barium study. (Furnished through the courtesy of Drs. Churchill, Elliott and Kinney of San Diego.)

amination, patient was given dye for visualizing the gallbladder. Figure 4 shows its position and absence of internal defects.

It will be noted that while the ring shadows obtained in our original films are essentially circular in form, there is enough irregularity in outline to suggest the faceted character of many gallstones.

In résumé, the visibility of the diverticula in our first films can only be attributed to the retention of dye previously administered, since no powders or opaque mixtures were taken. In a later plain series, not shown here, a more visible ring was probably due to barium coating the walls.

The rarity of this confusion between gallstones and regional diverticula in the bowel is best explained by the rarity of diverticula in this position. A diverticulum in the second portion of the duodenum might occasionally present the same chances for diagnostic error.

Visualization of the gallbladder by dye and visualization of the hollow organs by barium will, of course, serve to orient such shadows and prevent an error in what might otherwise be considered a rather clear cut demonstration of gallstones.

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CALCIFICATIONS IN THE SPLEEN*

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THE publication of this small series of 4 cases was suggested by the work of Bársony and Schütz.[1] They examined spleens from 180 autopsies in an attempt to prove that the usual calcifications in the spleen were phleboliths and not caused by tuberculosis. Seven out of the 180 spleens showed calcifications, and microscopic examination of the calcified nodes proved all to be phleboliths. All of the calcified spleens were in subjects over fifty years of age and 6 of them were between sixty and seventy-five years.

In about 350 cases roentgenographed at Roper Hospital from April to November, 1931, in which the splenic region was visualized, we found 4 cases showing calcifications within the splenic shadow. These calcifications are the same type as the phleboliths found so often in the pelvic circle.

The histories of the 4 cases, here presented, are most interesting in their negativeness. In only one case is there a possible etiological factor, Case II giving a definite malarial history. Not one of the patients had any symptoms or findings referable to the spleen at the time of roentgen examination.

An outline of the case histories is as follows:

CASE I. E.H., white, female, aged twenty-one. Complained of pain in the right lower abdominal quadrant. Roentgenograms made of the genitourinary tract were negative except for multiple, dense calcifications within the splenic shadow (Fig. 1). A subacute appendix was subsequently removed and the patient

FIG. 1. Case I. Multiple circular calcifications within the splenic shadow.

FIG. 2. Case II. Circular calcifications within the splenic shadow.

* From the X-ray Department of Roper Hospital and Medical College of South Carolina, Charleston, S. C.

made an uneventful recovery. There was no history of malaria; the chest was negative, and there were no phleboliths in the pelvic circle.

Case II. J.G.P., white, male, aged fifty-eight. Complained of difficulty in urination. Roentgenograms of the genitourinary tract were negative except for calcifications within the splenic shadow (Fig. 2). The final clinical diagnosis was benign hypertrophy of the prostate. The patient gave a past history of several attacks of malaria. There was evidence of healed bilateral apical tuberculosis; no phleboliths in the pelvic circle.

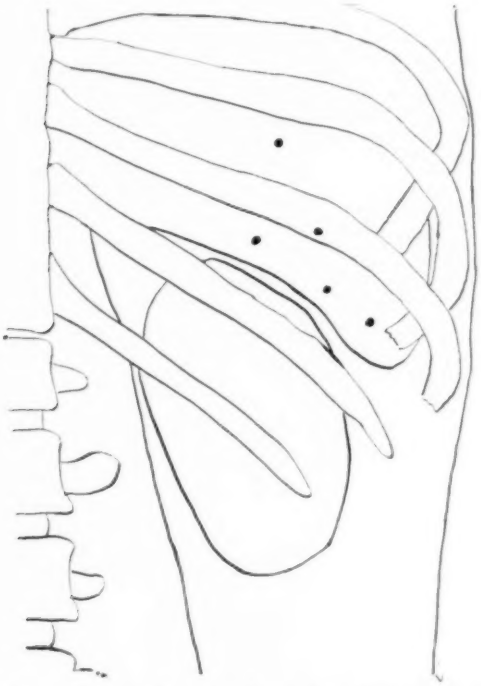

Fig. 3. Case III. Tracing from film showing location, size, and number of calcifications in the spleen. This tracing is used since the film did not reproduce well.

Case III. L.H., negro, male, aged twenty-eight. Complained of difficulty in urination. Roentgenograms of the genitourinary tract were negative except that the same type of calcifications as in the above two cases, though smaller, were visualized in the splenic area (Fig. 3). There was no history of malaria; the chest was negative, and there were no phleboliths in the pelvic circle.

Case IV. R.B., white, male, aged twenty-six. Complained of low back pain following heavy lifting. Roentgenograms of the lumbar spine were negative except for multiple, dense calcifications within the splenic area (Fig. 4). The back pain vanished after a few days rest at home. There was no history of malaria; chest not examined; no phleboliths in the pelvic circle.

A review of the literature fails to add any information as to the possible cause of phleboliths in the spleen. Only 4 other references to splenic calcifications were found and all of these were case reports. One of these by Bunch[2] is a proved case of tuberculous calcification.

Finally, a similar case to the ones in this series was seen by the author on the service of Dr. Paul C. Hodges at the University of Chicago in 1930. This was also an incidental finding and was reported as phleboliths in the spleen.

SUMMARY AND CONCLUSION

All of the splenic calcifications found in an autopsy series of Bársony and Schütz[1] were proved to be phleboliths.

The splenic calcifications observed in 4

Fig. 4. Case IV. Phleboliths (?) in the spleen.

cases reported here, because of their type, distribution, and lack of clinical manifestations are probably also phleboliths.

While tuberculosis is a proved etiological factor[2] of calcifications in the spleen it does not seem to be the usual cause for them.

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DIAPHRAGMATIC HERNIA WITH SEVERE ANEMIA*

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UNTIL quite recently diaphragmatic hernia was considered to be of comparatively uncommon occurrence. Up to 1923 only 47 cases had been diagnosed during life. Pancoast and Boles[1] state that only 7 cases were discovered roentgenologically in 25,000 cases examined; at the Mayo Clinic[2] only one case was found in 23,000 examintions, and of the 30 cases operated upon by Harrington during a period of four years only 3 cases showed severe anemia. However, recent reports from the Mayo Clinic as well as from other sources indicate that the percentage of discoveries of this malady is surprisingly on the increase. It is therefore rational to report these cases, not only because of their unique clinical aspect, but also as an incentive, both to the clinician and roentgenologist, to bear in mind the possibility of the existence of a diaphragmatic hernia in order to explain certain obscure symptoms and signs referable to the lower chest or upper abdomen, and also in cases of secondary anemia of unknown origin. A brief review of the subject is therefore also warranted.

CASE REPORTS

CASE 1. Mrs. B. B., aged sixty-four, came to my office on September 29, 1930, complaining that for the last four or five weeks she had been suffering from weakness, constant vertigo, palpitation of the heart on the least exertion, and of shortness of breath. For many years she had sour eructations periodically, associated with heart burn, and occasional pain referred to the region of the lower sternum, especially after meals. Relief is only obtained after spontaneous vomiting, by the intake of sodium bicarbonate, or after induced vomiting. The vomitus often appeared "black." These symptoms have become more frequent in the last two months. She has never suffered any severe abdominal pain or cramps. She has never been pregnant and does not recall any injury such as a fall or a blow of any moment. Her bowels have always been irregular. Her weight up to two years ago was 190 pounds; two months ago it was 170 pounds and at the time of her examination it was 164 pounds. On careful inquiry it was ascertained that this condition had existed for probably fifteen or more years. During the last two months she has been receiving treatment for diabetes because her physician found some sugar in her urine.

Physical Examination. The first striking sign was the patient's marked pallor, though she appeared to be fairly well preserved, without any evidence of loss of weight. Her skin, mucous membrane and conjunctivae appeared as in a case of severe anemia. Examination of the heart, lungs, abdomen and rectum was essentially negative. Her pulse was rapid but of fair quality. Urinalysis revealed nothing abnormal. Her blood pressure was 128/68. Hemoglobin was 25 per cent and the red blood count was 2,000,000.

In the light of these facts, a provisional diagnosis of carcinoma of the lower esophagus or cardia was made. Roentgenoscopic examination of the chest was again essentially negative, except that there seemed to be a dense shadow just overlying that of the cardiac shadow. This intensified the suspicion of the existence of a neoplasm in that location. A roentgenogram of the chest was taken and a similar finding recorded.

She was then given a barium and acacia mixture. This revealed an apparently normal esophagus, the lower end of which projected about 3 inches above the diaphragm. Below this normal constriction there appeared to be a circular dilated pouch with rather smooth outline, similating in its configuration and position a diverticulum of the lower end of the esophagus. After giving her two more glasses of barium mixture a series of roentgenograms were taken of the stomach, first in the anteroposterior and then in the oblique position. She was subsequently given another half glass of opaque substance and another exposure was made of the esophagus. This combined film disclosed about one-third of the upper portion of the stomach to be

* From the Department of Gastro-enterology, Beth Israel Hospital, New York City. Read before the East Side Clinical Society, Nov. 10, 1931.

herniated through the esophageal orifice into the thoracic cavity. The heart was displaced upward and to the left by the herniated shadow. The esophagus itself appeared normal and of the short type (Figs. 1, 2 and 3).

On roentenoscopic examination there appeared to be no obstruction to the passage of the barium, except for a slight delay at the lower esophageal constriction. The meal passed quickly through to the herniated pouch, down through the diaphragmatic constriction into the stomach. On manipulation, the barium from the stomach could easily be transferred back into the herniated portion. The stomach seemed to be fixed at the diaphragmatic constriction. Emptying time was normal, there being no retention. No other part of the abdominal viscera was found herniated. There was distinct evidence of thickening and hypertrophy of the herniated portion of the stomach. Both diaphragms were also well visualized.

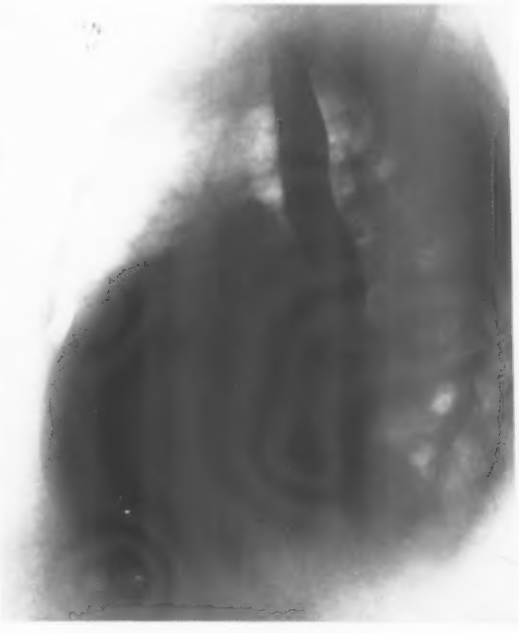

Fig. 1. Case 1. Note the normal esophagus with a filling defect at the lower end, and the left diaphragmatic arch below that.

It was fairly certain that we were dealing with a case of diaphragmatic hernia with gastric bleeding. In view of her severe anemia and the fact that a malignant degeneration had not been definitely excluded, she was admitted to the Beth Israel Hospital on October 2, 1930. The case was studied critically in collaboration

Fig. 2. Case 1. Note the dilated pouch above the diaphragmatic arch and the constriction of the stomach in the same region.

Fig. 3. Case 1. This clearly demonstrates the short esophagus, the permanently dilated pouch of the upper portion of the stomach, and the constriction at the diaphragmatic arch.

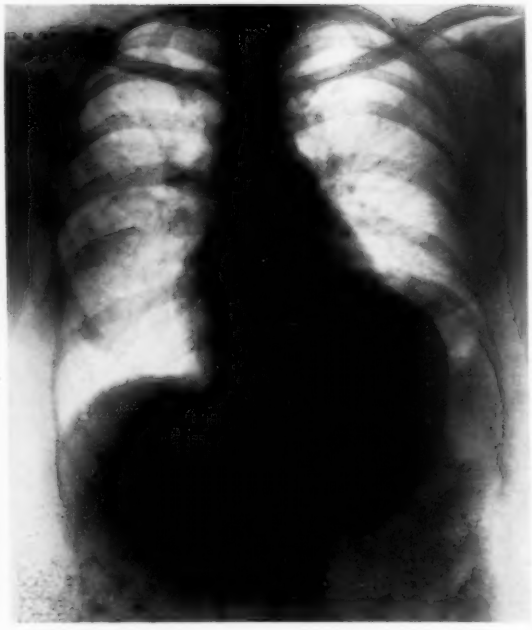

FIG. 4. Eventration for the purpose of differential diagnosis. Note the high left diaphragm.

with Dr. I. W. Held and Dr. J. J. Hertz. Esophagoscopy by Dr. J. W. Miller disclosed only a hyperemia and a marked thickening of the fold of the mucous membrane in the herniated portion of the stomach. The esophagus was normal and disclosed no evidence of any new growth. Examination of her blood showed hemoglobin 25 per cent, red blood cells 2,150,000, with a marked polychromatophilia, anisocytosis, poikilocytosis, macrocytes and microcytes. The white blood count was 3,400. She received a transfusion of 650 c.c. of blood and after seventy-two hours the hemoglobin rose to 33 per cent and the red blood cells to 2,420,000. There was no vomiting for six days, after which she vomited again a dark material that had a 4 plus benzidine.

For the next seven days she was given duodenal feedings every two hours, consisting of milk and cream, eggs, and orange juice. She was fairly comfortable and had no vomiting. The hemoglobin, on discharge, was 31 per cent and the red blood count was 2,460,000.

She is still under treatment. Her diet is just about the same as for any other peptic ulcer. She is also taking continuously pills of iron, quinine and zinc valerianate, and a preparation containing liver extract. Her hemoglobin continued to rise steadily as did also the red blood count and at present they are 72 per cent and 4,350,000, respectively.

From the experience gained from this case I was fortunate in finding another case of similar nature but of less severity.

CASE II. Mrs. M. K., aged fifty, came to my office on October 29, 1930, complaining that for many years she had suffered from indigestion and constipation but never of a severe nature. About May 1, 1930, she contracted a severe grippe and since then she has had many attacks of epigastric pains, coming on about one-half hour after meals, radiating to either side and sometimes upwards to under the lower substernal region. Several times the attacks occurred at night. For the last two weeks they have been more frequent and more severe, coming on day or night as soon as she takes any food. On several occasions morphine was required. Vomiting was not conspicuous, but nausea, eructations, and belching were very annoying. She lost much weight and felt quite weak. She was unable to tell anything about the color of her stools.

Physical Examination. Her heart, lungs and urine were normal. Abdominal examination revealed nothing except slight tenderness in the

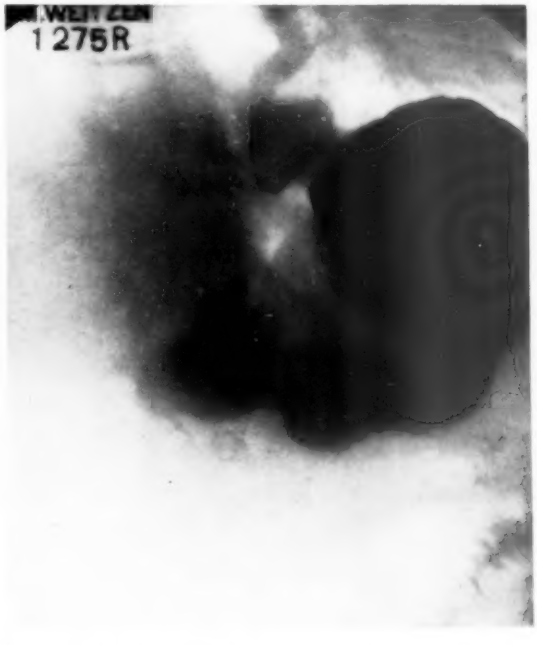

FIG. 5 Case II. Note the tortuous lower end of the esophagus and the herniated portion of the stomach just above the left diaphragm.

gallbladder region. Blood pressure was 120/66, hemoglobin 68 per cent and red blood count 4,100,000. Roentgenoscopy of the chest was negative.

Fasting Stomach Contents. Here I encountered the first clue to the situation. A Rehfuss tube was inserted very carefully and 150 c.c. of a dark brown fluid was withdrawn. This contained free HCl 30, total acidity 40, and benzidine 4 plus. Her stomach was then lavaged and the washing also contained numerous red blood cells. Cholecystographic examination revealed a normal gallbladder. Roentgenoscopic examination of the stomach with the barium meal revealed no abnormality, except an unusual tortuosity in the passing of the meal from the lower end of the esophagus into the cardia.

Roentgenograms of the stomach also failed to show any organic lesion except the disclosure of a triangular shadow between the cardiac end of the stomach and the shortened lower end of the esophagus. There was no gas bubble in the stomach. This shadow was definitely located above the diaphragm and evidently was a portion of the cardiac end of the stomach (Fig. 5). Subsequent films confirmed this finding by the outlines of some rugae in that sac.

Thus a diagnosis of diaphragmatic hernia with intermittent bleeding from incarceration was also made in this case, based upon the following facts: (1) the positive roentgen findings; (2) the laboratory evidence, and (3) the exclusion of any other organic lesion.

The treatment is essentially the same as that of Case 1. So far she has showed considerable improvement.

COMMENT

Diaphragmatic hernia is usually divided into traumatic, congenital, and acquired. LeWald[3] states that the acquired are really also congenital in the same sense as any other acquired hernia elsewhere in the body. In fact, there seems to be a close similarity between inguinal hernia and diaphragmatic hernia, and even the traumatic cases may really be of congenital origin, because of the weakness of the ring. There are various forms of traumatic hernias with which we are not concerned in the present paper.

As to the etiology of congenital diaphragmatic hernia, little is known. It occurs at the several natural diaphragmatic openings, but is most common at the esophageal hiatus, because this is the only opening that is muscular in structure, hence is amenable to dilatation.

Symptoms. These are due to intermittent incarceration and obstruction of the stomach, mechanically interfering with its function. This is manifested by attacks of epigastric distress during or shortly after any meal, the pain sometimes radiating to the back or left shoulder and left arm. Occasionally there is also dysphagia, but this is not very common. Belching of gas, or rather an inability to do so, is a frequent symptom. Substernal pain with regurgitation of sour material in the supine position, especially in the morning is, according to Healy,[1] a most suggestive symptom of this condition. Rarely the vomitus may contain blood or it may be tarry, indicating a severe incarceration. This is due to erosions or ulcerations of the mucous membrane induced by the pressure exerted by the contractions of the stomach upon the site of the incarceration. At times this condition may also cause respiratory and circulatory impairment. So that, contrary to the prevailing opinion, even small diaphragmatic hernias frequently present symptoms of some kind.

Diagnosis. Owing to the variable nature of the symptoms of diaphragmatic hernia, the diagnosis is seldom made clinically. It is only accidentally discovered during a roentgenologic examination. Failure to demonstrate it is most frequently due to spontaneous temporary reduction, lack of filling of the fundus, or to the position of the patient when no barium is retained in the herniated portion of the stomach. In the upright position it is almost never demonstrated, since small hernias may be obscured by the heart shadow. Omental hernias can never be demonstrated. Absence of the gas bubble is a very suspicious sign, and to differentiate it from cardiospasm the examination in the Trendelenburg positon may be of aid. Roentgenoscopy of the esophagus with the opaque substance will often give the first indication

of its presence. The barium may be observed to pass through a tortuous lower third of the esophagus. Above all, it may be due to the fact that diaphragmatic hernia is seldom suspected and is therefore missed.

Differential Diagnosis. This is again a roentgenologic problem. Diaphragmatic hernia must be differentiated from (1) eventration of the diaphragm, (2) hourglass stomach, (3) esophageal diverticula. Of prime importance is the demonstration of the diaphragmatic arches. Clinically, the substernal pain and pressure may have to be differentiated from angina pectoris and coronary sclerosis. Biliary colic is not relieved by belching or vomiting and the pain is mostly located at the right hypochondrium. It is worthy of note that in all cases of apparent attacks of biliary colic and with a positive cholecystogram and negative findings in the stomach, diaphragmatic hernia should be suspected and its presence or absence determined by a careful roentgenologic study. The best technique for that purpose seems to be the examination of the barium-filled stomach in the right oblique, prone, or Trendelenburg position. Examination of the colon with the barium enema is also advisable in all doubtful cases. Right-sided diaphragmatic hernia is comparatively rare.

Treatment. Early diagnosis is of prime importance. Palliative treatment in mild cases consists only in the avoidance of heavy meals, and in not lying down after any meal. More severe cases, especially those with evidence of bleeding ulcerations, are assumed to be present even when not demonstrable, hence should be treated in the same manner as any other bleeding gastric or duodenal ulcer. Duodenal feeding for one or two weeks, followed by a routine ulcer regimen, seems to give the best results. In cases that do not show definite improvement within a reasonable time, and in those with recurrence of bleeding, surgery is indicated. For those with a poor surgical risk, however, Harrington of the Mayo Clinic advises an evulsion of the left phrenic nerve. The subsequent relaxation of the diaphragm results, likewise, in a relaxation of the hernial ring, thereby preventing further incarceration.

The inference to be drawn from this report is, first, that we have definitely demonstrated the occurrence of congenital hernia of the stomach associated with severe anemia manifesting few or no symptoms of any consequence during almost the entire life of the individual; secondly, that mild bleeding of the above description is compatible with a fair degree of health. It is evident that Case 1 has had periodic attacks of hemorrhage from inflammatory erosions, aneurysms, or varicosities located in the mucous membrane of that portion of the stomach which is adherent and constricted at the esophageal ring; thirdly, that in all cases presenting severe gastric symptoms with negative findings in the stomach and gallbladder, the possibility of a diaphragmatic hernia should be considered, thus sometimes sparing the patient an unnecessary operation on the gallbladder or appendix.

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AIDING RESEARCH IN RADIOLOGY*

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PERHAPS few of us realize the great rôle played by radiology in the development of science and industry today. The food we eat, the clothes we wear, the vehicles in which we ride on land, over water, or through the air, the entertainments we enjoy, the business of the world in which we all have a part, the diagnosis and treatment of disease—all are more or less dependent upon radiations of one or another set of wave lengths.

Most of our knowledge of the uses of various radiations for all these purposes has been developed in the purely scientific laboratory. Commercial organizations have taken up the threads of knowledge discovered by the pure scientist, and have developed and patented innumerable devices for practical and commercial purposes. The inventions of the pure scientist are too often capitalized and controlled by wealthy corporations, who employ lawyers familiar with all the tricks of the profession to secure control of patents, which ofttimes they do not even use, because in so doing they would lessen the monetary value of other inventions. These patents put out of the way may be of far more value to humanity, but, because they lessen the monetary return to the corporation they are bought up and often set aside. Radiologists who require the use of patented apparatus, and, ultimately, the people whom they treat, must pay the higher prices for less efficient equipment with the result that the cost of medical care grows higher. The final result is generally to impede the progress of the science concerned.

On the other hand, radiology has had a fairly rapid development during the past thirty-five years, and we must all acknowledge our indebtedness to the manufacturer for the large part he has had in this development. With prospects of good profit, and stimulated by keen competition in business, he has made many contributions of the greatest value in radiological research. For these he must have due credit and not be criticized too severely—he did his best to create a monopoly and increase profits, it is true, but that is the natural tendency of business. And so, while the manufacturer has been more or less of a handicap to the development of radiological science, he has also been indispensable in the development of the art.

After several years of wrestling with some of the problems connected with monopoly in radiology, and realizing that too frequently the labors of the purely scientific inventor were capitalized by the strong financier, and that the profits of such capitalization did not go back into the development of science, as at least a part of them should, a few radiologists got together at the time of the American Medical Association meeting in Detroit and started The Radiological Research Institute which, it was believed, would be of great help in the development of the science and art of radiology by encouraging research in every way possible, especially by financial aid by securing and controlling patents and administering them for the benefit of the patentee and of the science and art of radiology instead of a few financiers. This organization has the following objects in view:

To establish, equip and maintain a central research laboratory for the purpose of conducting research in radiology and all fields and things pertaining thereto.

To stimulate research in radiology and allied arts and sciences that may be considered of value in the prevention, diagnosis and treatment of disease, especially cancer.

To cooperate with the National Insti-

* Read at the Thirty-second Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 22–25, 1931.

tute of Health, or with any individual, corporation or institution that it may deem advisable in this or any other country.

To create one or more fellowships, when deemed advisable in any institution or laboratory engaged or intending to engage upon special research problems in radiology and allied arts and sciences.

To collect, correlate, and disseminate all available scientific knowledge in the field of radiology and the allied arts and sciences.

To investigate and develop the production and application of radium and other radioactive substances.

The Institute was incorporated under the Laws of Delaware on August 27, 1930. A Board of Directors was elected and plans were laid for carrying on what seemed to be the most important research at the time. During the past year an Advisory Committee has been named. It is composed of well-known men in many different fields of radiological work. It will be their duty to advise upon the need for any particular type of research work and to plan for carrying it out.

In the meantime, the Board of Directors with the aid of several men on this committee inaugurated research work in three different localities. First of all, in the Fall of 1930 three men were given fellowships and were put to work on research which had been started by Prof. George L. Clark of the University of Illinois, namely, the development of a roentgen-ray tube. Later a fellowship was established at the California Institute of Technology at Pasadena, California, under Dr. Robert A. Millikan. The man holding this fellowship is working with Prof. Lauritsen on the development of the higher voltage radiation. Still another fellowship has been established a short time in the Bureau of Standards at Washington to work with Dr. Lauriston S. Taylor on the development of some practical standardization of roentgen-ray apparatus.

The Radiological Research Institute joined with the Chemical Foundation, the Radiological Society of North America and the Federal Telegraph Company in appealing to the United States Supreme Court a decision of the United States Court of Appeals on the validity of the Langmuir Patents claimed for vacuum tubes. The decision of the lower court and later of the United States Court of Appeals did not recognize the Langmuir patents. The attorneys representing the latter, however, secured a re-hearing and the United States Court of Appeals reversed its own former decision. Then it was, that, in the interests of humanity, the Radiological Research Institute, urged and joined others to appeal to the United States Supreme Court, which reversed the re-hearing decision of the United States Court of Appeals. The Radiological Research Institure was especially helpful at this time in preparing a brief as Amici Curiae and of Amici Curiae, giving the history of the development of the roentgen-ray vacuum tube, which apparently was valuable in aiding the Supreme Court to see the justice of the appeal, and the result was that the patent monopoly of roentgen-ray, radio and other vacuum tubes in this country was disposed of.

The Institute has also joined in another appeal to the Supreme Court, namely, to have the decision of the United States Court of Appeals in regard to the Lilienfeld patent reversed.

This activity in the courts must not be construed as any personal antagonism against any particular company, but simply as an effort to protect the radiologist and the public from the bad effects of unjust patent monopoly, and to remove barriers against the higher development of the roentgen-ray art and science by many other capable individuals who have been handicapped and prevented by the monopoly.

These accomplishments during the first year of the existence of this corporation we think more than justify its continued existence. We believe it is the privilege, if not the duty, of everyone interested in radiology, whether he be a physician, a manufacturer, or a pure scientist working in biology, pathology, physics, chemistry,

etc., to become a stockholder in this Institute. Thus he will aid the support of its philanthropic and humanitarian interests.

It must be remembered that the Institute is a non-profit-sharing corporation. Should it control any patents that might prove of value in a financial way, so that it might receive some financial profits therefrom, these profits would go back into the development of radiological research. No stockholder will receive any financial profit from his stock, nor will any officer for his work. It is purely philanthropic. The only benefits that will come to him will be the satisfaction of having done his share to contribute something toward the development of the science and art of radiology, which is proving to be of greater value to the human race perhaps than any other development in the history of the world.

DISCUSSION

Dr. Edwin C. Ernst, St. Louis, Mo. I appreciate the opportunity of merely emphasizing a few of the points discussed by Dr. Stevens and perhaps adding one or two sidelights.

You have heard that many of the new developments in the various arts and sciences owe much to radiation, in which we are interested. Many of the old theories of fundamental sciences have either been strengthened or discarded since the advent of the phenomena of radiation. But in medicine perhaps no one better than ourselves can realize what has and perhaps will be accomplished within the next decade through the channels of research in radiology. Everything, however, depends upon an open field in research and the proper coordination of the efforts of those who are willing to sacrifice the necessary time in this direction, irrespective of any monetary consideration other than the immediate necessary funds in the initial endeavors of an undeveloped idea.

Perhaps we may be able to be of service through this Institute in that direction. There have been periods in the progress of research of very rapid changes, development, and then perhaps a lull, a stasis, and this has been especially true in the development of apparatus, particularly x-ray tubes. Fortunately, some of these obstacles have recently been removed by a very important and favorable court decision, and the future research developments in this direction have already reacted favorably, as shown by the renewed activities by not only one, but many capable investigators and research laboratories, as presented by Dr. Stevens. This Institute has been active in many other national problems, other than those mentioned this morning, particularly radiological researches and activities, that have been of inestimable value to the practice of radiology as a whole, as well as to the future of our profession. These advances should prove to be of vital importance to the future progress in reference to the ever-present and serious cancer question.

The efforts of this organization and its directors to stimulate and encourage radiological researches were first begun about a year ago, and Dr. Stevens has told you of the plans and the present developments of the advisory committee. Remember that this organization is active only as a liaison between all of the medical organizations, the five major radiological societies, and thus aids, studies, coordinates and correlates researches in radiology for your best interests as radiologists to the benefit of humanity as well as to the closely allied sciences and industries, and this is done without any profit to the Institute or its members.

There are many new prospective radiological problems with special reference to new types, perhaps better x-ray tubes, some of which researches will be under the direction of members of your Society. Therefore, your continued cooperation will help to broaden this field of research endeavors and also benefit each and every one of you interested in the practice and future development of radiology.

Without the cooperation of so many of you conservative, yet foresighted radiologists who have recognized the need of a non-political and unselfish type of inter-society activity, without regard to any of the established policies of any particular organization, especially delicate questions or methods of procedure which at times very seriously involve this institution, could not have weathered the many obstacles thrown in its path from time to time. It was the loyal support and confidence and the necessary stimulation that you gave to the officers and to the members of the Radiological Research Institute that has made it possible to continue this work in the interest of science and the practice of radiology and research.

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Eighteenth Annual Meeting: Chicago, Ill., Sept., 25–30, 1933.

EDITORIALS

SKELETAL AND LIGAMENTOUS CHANGES ASSOCIATED WITH FLUORINE ABSORPTION

MØLLER and Gudjonsson,[1] in the course of a series of investigations on the incidence of silicosis among workers in dust-producing industries, had the occasion to examine a number of employees engaged in the crushing and refining of cryolite. The work was dusty and since cryolite in the early stages of the refining process contains a certain amount of quartz, it was thought likely that this dust would produce silicosis. The results of their investigations brought to light many interesting observations.

It was found in the employees examined that at least four different affections were frequent, all of which were typical occupational diseases. They were: silicosis, abnormal changes in the bones, an acute affection of the stomach and pronounced oligohemia. These findings were rather unexpected as the primary interest in this particular factory was the determination of the presence of silicosis. This they found in varying stages. In none of the subjects examined, however, had the silicosis developed beyond the second stage. The majority of the workers examined showed a silicosis of the second stage though some of these were severely affected.

During the course of the examination of the chest Møller and Gudjonsson observed, in addition to the silicosis, a "curious whiteness and density of the shadows of the ribs, claviculae and cervical vertebrae, differing considerably from the bone-design one usually finds in roentgenographs of the lung." They were also puzzled by the unusually long exposures required to procure satisfactory roentgenograms of the lung detail. Owing to the peculiar changes observed in the cervical vertebrae and ribs, it was decided to investigate the entire skeleton. The peculiar white dense shadow of the bones suggested "marble bone disease" but subsequent detailed examinations showed the changes to be different from marble bones, and associated with the bone changes were definite clinical symptoms entirely different from those observed in marble bone disease. The changes were so striking and so completely at variance with those observed in any other known disease —the bone changes most closely simulating these are those observed in metastases from carcinoma of the prostate—that Møller and Gudjonsson came to the conclusion that the skeletal changes, as well as the silicosis, were definitely associated with the occupation. Varying degrees of bone changes were observed, depending upon the length of time the employees had been working in the factory, from the earliest demonstrable changes to the more severe cases where the spongy bones were altered both in structure and outline, and the normal bone trabeculation was completely effaced, this being replaced by bone of a "milky white opacity." The contours of the vertebrae were also altered. Not only were the vertebral bodies themselves altered but the transverse processes were observed to be quite "plump, thick, and covered with small excrescences" and the spinous processes appeared as dense irregular bands, and there were definite calcium deposits along the ligaments and the fibro cartilaginous attachments. The ligaments over the anterior aspects of the vertebral bodies were so extensively calcified as to actually bridge between the vertebrae such as is

[1] Møller, P. Flemming, and Gudjonsson, Sk. V. Massive fluorosis of bones and ligaments. *Acta Radiol.*, 1932, *13*, 269–294.

seen in severe cases of spondylitis deformans. The posterior portions of the ribs along the edges in the advanced cases showed large irregular excrescences resembling "hoar-frost needles" as the result of calcifications in the attachments of the intercostal muscles. The bones of the pelvis showed the same opaqueness and density as were observed in the vertebrae and there was noted in many of the cases calcification in the ischiosacral ligaments.

In the extremities the compact layers of bone were shown to be much thickened and the marrow cavities narrowed. The small bones of the hands and feet showed the same dense opaque-like whiteness seen in the vertebral bodies.

The stomach symptoms of which the employees complained were nausea, lack of appetite and vomiting. The workers themselves attributed this to the quantity of dust present; the more dusty the particular room in which they worked, the more pronounced were the gastric symptoms. The patients also complained of drowsiness, a certain amount of excessive salivation, pressure on the heart and chest, and belching, with frequent obstipation. The stomach symptoms often manifested themselves shortly after the employees came to the factory. It was evident that these symptoms were due to the inhalation of the dust as a careful study of the patients revealed an organic lesion of the stomach (an ulcer) in only one case. After a certain length of time the more disagreeable gastric symptoms disappeared and the only gastrointestinal symptom of which the patients complained was the obstipation.

The various toxic symptoms, lung and bone changes could all be explained satisfactorily on the basis of the type dust in which the employees worked. Since cryolite in its crude state is mixed with a considerable amount of quartz, this would explain the silicosis. "The cryolite itself which is a fluoride of sodium and aluminum, contains a great amount of fluorine—as much as about 54 per cent. Neither aluminum nor sodium is known to provoke symptoms such as were observed in these cases. Fluorine, on the other hand, is known to be a highly toxic substance and is capable of being deposited in the bones."

It has been known for some time in animal experimentation (Forbes,[2] McClure and Mitchell,[3] and others) that phosphate minerals used as calcium supplements in animal nutrition may exert a harmful effect. These effects are manifested in a definitely toxic manner such as impaired appetite, disturbances of the general health of the organism and, more specifically, a faulty bone and tooth development. It has been proved experimentally that sodium fluoride does not, as the sodium salts of the other halogens, become excreted in the urine immediately after ingestion by mouth, but that most of the sodium fluoride administered orally is retained in the organism as calcium fluoride. Brandl and Tappeiner[4] reported from animal experiments on dogs the deposits of abnormal amounts of fluorine in various body tissues as the result of the continuous administration of small amounts of fluorine in the ration. They noted at necropsy that the attachments of the muscles and the fibrocartilage presented some very extraordinary changes. The cartilages were quite rough and opaque and entirely white, the bones had a more or less luminous whiteness with a velvety sheen, the elasticity of the bone was considerably reduced and the cartilages were difficult to break. The teeth were defective and porous and the roots eroded but the crowns of the teeth remained whole. Microscopic examination showed that the Haversian canals were practically completely filled with numerous "shiny, octahedral crystals, found to be calcium fluoride" and the Haversian canals were so completely filled with this material it was difficult to understand how there was still room for the capillaries. These experi-

[2] Forbes, E. B. Quoted by McClure and Mitchell.

[3] McClure, F. J., and Mitchell, H. H. The effect of fluorine on the calcium metabolism of albino rats and the composition of the bones. *J. Biol. Chem.*, 1931, 90, 297–320.

[4] Brandl, J., and Tappeiner, H. Quoted by Møller and Gudjonsson.

ments, along with those of McClure and Mitchell, prove that soluble fluorine salts can be absorbed through the alimentary canal and become deposited in the organism, especially in the bones and ligaments.

All the animal experiments were carried on by gross and microscopic studies; no roentgen examinations were made of the skeletons of these animals. Since the skeletal changes observed roentgenographically in the cryolite factory workers examined by Møller and Gudjonsson simulate to a marked degree those observed in the animal experiments, it is reasonable to conclude that the osseous changes in the workers were due entirely to the fluorine contained in the cryolite, and that the bone changes were in direct proportion to the length of time that the individuals had engaged in the work. In the early stages the changes were only slight; in the older workers, as the changes became more pronounced and the calcification more extensive, they exhibited stiffness in the limbs and the mobility of the spinal column became markedly impaired, some of the workers complaining of being troubled with "rheumatism."

It might be expected in such a widespread sclerosis of the spongy bones with the narrowing of the marrow cavities of the long bones that there would be changes in the blood picture, and such was found to be the case in the majority of the workers examined. There was a reduction in the number of red cells, associated with anemia in many of the cases. The white cell count presented no abnormality. It was thought from the blood cell studies that the anemia was due entirely to the diminution of the red bone marrow as the result of the sclerosis.

As a result of the examination of these workers and the extraordinary bone changes observed, it was thought of interest to examine workers in other industries where cryolite and other materials containing fluorine were used. A number of enamel factory workers were examined and glass workers whose particular occupation was etching of glassware and some were examined in the sulphuric acid factories. None of these, however, exhibited changes such as were observed in the first group of workers. The absence of any changes in the enamel, glass and sulphuric acid workers was attributed to the fact that they were exposed only to breathing an air or fumes saturated with fluorine, while the cryolite workers not only inhaled the dust but got it into their mouths and swallowed it. It is supposed that the fluorine particles when swallowed are acted upon by the hydrochloric acid in the stomach and become converted into hydrofluorine and that this chemical change causes an acute corrosion of the mucous lining of the stomach which is the cause of the gastric symptoms. It is then supposed that the fluorine undergoes still further changes and becomes absorbed in the alimentary canal and deposited in the bones and the fibrocartilages as calcium fluoride. Certainly these are the changes that take place in animals and since the bone changes observed in the human are identical, apparently the same process must take place. Some such hypothesis as this must be assumed as none of the workers in the glass, enamel and sulphuric acid industries who were examined exhibited any symptoms of acute poisoning or showed any signs of pathologic changes in the bones. Møller and Gudjonsson concluded therefore that the changes which they observed were due to the cryolite dust and were caused by the dust being swallowed and the fluorine being absorbed through the alimentary canal.

These observers suggest from their study the possibility of employing fluorine therapeutically, especially in such bone diseases as osteogenesis imperfecta, osteomalacia, disseminated osteitis fibrosa, and like diseases, which result in pronounced osteoporosis. It also opens up for study the entire question of the relation of fluorine to calcium metabolism since fluorine in small amounts is a normal constituent of bone. Inhalation of fluorine vapors has been tried in the therapy of pulmonary tuberculosis

on account of its disinfectant properties but was soon abandoned. Møller and Gudjonsson explain the ineffectiveness of this therapy on the basis that fluorine is apparently not absorbed through the respiratory tract. They suggest, however, that fluorine may be of benefit in bone tuberculosis and suggest the possible administration of small amounts of fluorine as a therapeutic measure in this disease.

MYRON B. PALMER
1873-1932

DR. Myron Botsford Palmer died in the Strong Memorial Hospital, Rochester, New York, on July 24, 1932, of acute ileus following an appendectomy.

Dr. Palmer was born in Ontario, Wayne County, New York, on August 27, 1873. He was the son of Oscar and Amelia Botsford Palmer. His primary and secondary school education was obtained in the schools of Webster, in the adjacent County

of Monroe. He prepared himself for college at the Normal School at Geneseo, New York, whence he matriculated in the Medical School of the University of Pennsylvania in the autumn of 1895, from which he was graduated with the degree of Doctor of Medicine in 1899. The following year, after a trip around the world in a tramp steamer, he returned to Rochester and entered the Rochester (N. Y.) General Hospital as an interne, completing his service in October, 1900. He immediately began to devote his professional activities to roentgenology, which at that time was in its early evolutionary stage. From 1901 to 1910 he was assistant roentgenologist being promoted to roentgenologist, with membership on the staff of the Hospital in the latter year. In the latter capacity he served his Hospital until 1926. During this period he was also consulting roentgenologist to the Monroe County Tuberculosis Hospital.

Upon the organization of the Medical School of the University of Rochester and its affiliated Hospital, the Strong Memorial Hospital, he became a member of its staff, in which capacity he served until his death.

On June 23, 1917, Dr. Palmer was commissioned Captain in the Medical Corps of the United States Army and was ordered to Camp Greenleaf, where he was assigned to duty as instructor in x-ray technique. Later he was transferred to the office of the Surgeon General of the Army in Washington, where he was assigned to duty as personnel officer of the X-ray Division. He was honorably discharged on February 1, 1919. He then returned to Rochester and resumed his private and hospital practice of roentgenology. He was one of the few fortunate early radiologists to escape dermatitis and the subsequent malignant changes from which so many of the pioneer men in this field suffered and died.

Dr. Palmer's interests, outside his profession, were in farming and in painting. Upon the death of his father and mother he retained a beautifully situated farm upon the shore of Lake Ontario near Union Hill, Monroe County, where he cultivated trees, particularly the conifers, many of which he disposed of commercially. He lived during a part of each year on this farm.

His painting was in the field of Marines, and during the past few years he had produced a number of works which received favorable criticisms.

As a radiologist the writer has always been impressed with his accurate technique, his painstaking efforts to get the best results for his professional colleagues who referred patients to him, and his conservative judgment in interpreting the results of the mechanics of his work. He originated many devices of value in the technical side of radiology, and improved others.

He was a fellow of the American Medical Association, a member of the Medical Society of the State of New York, of which he was at one time Vice-President, and of the Medical Society of the County of Monroe. Upon the organization of the Rochester Medical Association, he was one of the active group of physicians responsible for its success; the Association later combined with the Rochester Academy of Medicine, retaining the name of the latter society. He was a member of the American Roentgen Ray Society, the New York Roentgen Society and of the Rochester Roentgen Ray Society, of the Rochester Pathological Society, of which he was President in 1910, and of the Pennsylvania Club. He was also a member of the Nu Sigma Nu Medical Fraternity.

In 1908 he married Lucy Price, a daughter of Dr. Mordecai Price, of Philadelphia, who with a son, Myron B. Palmer, Jr., survives him.

Dr. Palmer died at the age of fifty-eight years, beloved by his family and friends and respected by all with whom he had even casual relations.

JOHN M. SWAN

THURMAN A. HULL
1880-1932

DOCTOR Thurman Alson Hull was an example of what is far too rare in the medical profession, a man whose work was highly specialized but who was at the same time a physician of great general ability, highly respected as such in his community. When he passed away the papers of his home city published appreciative articles on his life and his place in the community. The following quotation shows the esteem in which he was held:

"Dr. Hull was essentially the friend of his patients. He had a wide practice, and those into whose homes he came looked upon him as one of themselves. He seemed to have the capacity for making their troubles his own, and his advice often went far beyond the ordinary confines of the treatment of disease into the treatment of those worries and problems which too often culminate in illness if they cannot be solved. . . . it is not any depreciation of his manifest talents in radiography to say that he will be longest remembered by those who loved him—and they were many—in the way he would wish to be remembered—as an old-fashioned 'family doctor'."

He will be remembered in his own city not only for his abilities as an able practitioner of medicine but for his interest, extending over many years, in all those social and political problems which are so closely related to problems of the community's health. Beyond this he will be remembered by his friends everywhere as a kindly, genial and courteous gentleman.

Dr. Hull was a long-time member of the American Roentgen Ray Society and was closely identified with the problems of organized medicine through membership in the New York State Medical Society and the American Medical Association.

His friends in the American Roentgen Ray Society join with his other friends everywhere in expressing their sympathy to his wife and daughter who survive him.

Arthur C. Christie

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Chicago, Ill., Sept. 25–30, 1933.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Chicago, Ill., Sept. 25–30, 1933.

Section on Radiology, American Medical Association
Secretary, Dr. J. T Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Milwaukee, Wis., 1933.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: Chicago, Ill., Sept. 25–30, 1933.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. D. R. MacColl, 2826 S. Hope St., Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.

Brooklyn Roentgen Ray Society
Secretary, Dr. G. W. CRAMP, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

Cleveland Radiological Society
Secretary, Dr. M. A. Thomas, Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla
Meetings held twice a year, May and November.
Next meeting, Jacksonville, November, 1932.

Illinois Radiological Society
Secretary, Dr. L. M. Hilt, Myers Bldg., Springfield, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Michigan Association of Radiologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next Meeting, Hurley Hospital, Flint, Mich., January 31, 1933.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis.
Meets first Friday in October, December, February and April. Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn. Next meeting, Minneapolis, Minn., February, 1933.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. M. T. Powers, 250 Genesee St., Utica, N. Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. S. L. Warren, Strong Memorial Hospital.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary: Dr. R. B. Taft, 105 Rutledge Ave., Charleston, S. C.
Meets at time and place of South Carolina State Medical Association. Next meeting, Spartansburg, April, 1933.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstock strasse 10, Hamburg, Germany.

SÜD-UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Meets first Tuesday each month, October to July.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

DR. COOLIDGE APPOINTED DIRECTOR OF RESEARCH LABORATORY

Following the resignation of Dr. Willis Rodney Whitney, director of the research laboratory of the General Electric Company, Dr. William D. Coolidge was appointed his successor. Since the establishment in 1900 of the research laboratory under the direction of Dr. Whitney, and in association with Dr. Coolidge and Dr. Irving Langmuir, the reputation for original research in this laboratory has received worldwide recognition, especially for its work in drawn or ductile tungsten, the gas-filled incandescent lamp, modern high-power electronic, or vacuum tube, improved x-ray tubes and atomic hydrogen welding. It is particularly for their studies on improved x-ray tubes that the medical profession is indebted. At the beginning of Dr. Coolidge's experimental work the roentgenologist had at his disposal only the uncertain, temperamental gas tubes, and as a result of the research work of Dr. Coolidge and his associates we now have the dependable and flexible hot cathode type tube with which all roentgenologists are familiar.

The many friends of Dr. Coolidge throughout the world will be pleased with the announcement of his appointment and particularly the readers of this Journal through whose columns Dr. Coolidge has made known the results of so many of his research studies. They extend to him their best wishes in his new appointment, and these felicitations carry with them the hope that the new honor and added duties will not prevent his continued research in the field of roentgenology which has been so epoch-making.

MICHIGAN ASSOCIATION OF RADIOLOGISTS

During the meeting of the Michigan State Medical Society plans were formulated for the organization of the Michigan Association of Radiologists. Two subsequent meetings have been held and the following officers elected: President: Dr. A. W. Crane, Kalamazoo; Secretary-Treasurer: Dr. S. W. Donaldson, Ann Arbor.

The objectives of the association are to bring the roentgenologists of the state (approximately sixty in number) into closer relationship; to cooperate with the Council on Medical Education and Hospitals of the American Medical Association; to discourage exploitation of roentgenologists by hospitals and groups; to curb activities of lay and unqualified practitioners and to encourage qualified practitioners of roentgenology; to plan an educational program to acquaint physicians with the advances made in the field of roentgenology; to develop a basis for x-ray consultation and to promote greater cooperation between the clinician and the roentgenologist. Three meetings a year are planned.

RADIOLOGICAL CONFERENCE

The Philadelphia Roentgen Ray Society will conduct a Radiological Conference on Friday and Saturday, January 27 and 28, 1933. The meeting will be held at the Jefferson, University, Temple and Graduate Hospitals. All radiologists and members of the medical profession are cordially invited to attend these meetings. Further details may be obtained from Dr. Karl Kornblum, University Hospital, Philadelphia, Pa.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Endocrine Medicine. By William Engelbach, M.D., F.A.C.P., B.S., M.S., D.Sc., Professor of Clinical Medicine, St. Louis University School of Medicine, 1911–1924; Physician-in-Chief, St. John's Hospital, 1909–1924; Member of Staff of St. Louis, City, Jewish, Baptist Sanitarium, and Maternity Hospitals, etc. With a Foreword by Llewellys F. Barker, Professor Emeritus of Medicine, Johns Hopkins University School of Medicine. Three Volumes and an Index Volume. Cloth. Price, $35.00. Pp. 1795, with 933 illustrations. Springfield, Illinois and Baltimore, Maryland: Charles C Thomas, 1932.

These volumes, the completion of a monumental task, are a veritable storehouse of endocrine knowledge. The materials include a complete summary of the voluminous but convincing experimental work done to date, and in addition, and of the most value to the general profession, present the diagnostic and therapeutic conclusions derived from the author's vast amount of personal clinical experience. One of its greatest assets is that throughout a spirit of rational conservatism is maintained, serving to lend credibility and dignity to this field which has so frequently heretofore been shrouded in a haze of ill favor to the honest-minded physician because of vaunted and baseless claims of hyperenthusiastic physicians and unscrupulous pharmaceutical houses.

The first volume, termed "General Considerations," is devoted to the cytological, physiological and experimental development in this new field. This, indeed, gives abundant proof that the subject is now established upon a firm basis. Its chapters should be carefully read and digested in order that logical clinical application of these truths may ensue. An important phase in this volume, too, includes the methods and means used in making an endocrine diagnosis, emphasizing the differential points in regard to endocrine dysfunction and non-endocrine disease as met with in a routine diagnostic survey.

The second and third volumes are entirely clinical and present the diagnostic signs of the various endocrinopathies, taken up according to important life epochs, namely, infancy, the juvenile period, adolescence, and adult life. The diagnostic side is especially stressed, with less emphasis, rightly, upon therapy at this time. Such emphasis is basically sound because endocrine medicine in the ideal implies specificity in therapy, and such specificity can be attained only by the individual physician's ability to make specific diagnoses.

Another interesting phase of these two volumes shows the wide relationship of this new branch of medicine to the various specialties, including public health.

The chapters devoted to the roentgenographic studies of osseous development should prove of value to the roentgenologist. These roentgenographic studies make this material of greater diagnostic import. It is stated with regret that the roentgen conclusions from this group in this regard are at present entirely too general to be of any value to the general physicians interested in endocrine medicine. The charts showing the time of appearance of the various centers of ossification in the so-called normal are derived from a study of the various authorities and necessarily show a rather wide fluctuation. The author's conclusions are more arbitrarily fixed, and his basis for this fixation of the time of appearance of the various osseous centers is the result of his personal observation of over 2,000 endocrinopathies. That further changes in these charts will be made, he readily admits, but they serve for the present as an excellent standard, bearing in mind that most laboratory procedures are of value only when their proper correlation confirms or negates the presenting clinical evidence.

New developments are to be expected in this field, and the preservation of this excellent work will necessitate revisions as these developments occur. The volumes, as they stand, however, will prove of basic reference value to all medical men who wish to be well informed upon the developments and procedures in a field that is so rapidly increasing in its outlook and importance.

The excellent publication of these volumes is due to the personal care and attention of Mr. Charles C Thomas.

Robert L. Schaefer

THE CARDIAC OUTPUT OF MAN IN HEALTH AND DISEASE. By Arthur Grollman, Ph.D., M.D., Associate Professor of Physiology, Medical School of the Johns Hopkins University, Baltimore, Maryland. Cloth. Price, $4.00. Pp. 325, with 15 illustrations. Springfield, Illinois and Baltimore, Maryland: Charles C Thomas, 1932.

As the author states, an estimate of the cardiac output is of great importance because it is "the only objective measure of the functional activity of the circulatory system." Although there has been considerable interest in this aspect of the circulation for a good many years, the reported results have been confusing. As the exact status of the subject is not clear in the minds of many, it seems appropriate that the author should review the literature in a critical fashion and add an account of his own recent careful observations.

The first few chapters in the book deal with the various methods which have been used in the past to estimate the cardiac output and a critical appraisal of their accuracy. The acetylene method, introduced by the author in 1929, is then presented in complete detail and evidence adduced which indicates that it is the method of choice. This latter statement is in accord with the opinion of a majority of investigators who are familiar with the subject. Convincing evidence is offered which indicates that the cardiac output of man is constant when taken for short intervals during the day and likewise is not subject to daily or seasonal variations. The normal output is given as $3.9 \pm .2$ per minute. Careful observations show that the output is independent of posture, that it increases following the ingestion of a heavy meal, and, although it falls during sleep, it is only slightly lower than it is after complete rest.

Subsequent chapters deal with additional physiological variations, the effect of various drugs, and finally the clinical applications of cardiac output studies. Included in these are the output in heart disease, hypertension, anemia and polycythemia, hyperthyroidism, fever and pregnancy. In the final chapters of the book, the correlation of the cardiac output with other physiological functions is considered. This concerns the relation between cardiac output and the metabolism, the pulse rate and velocity of the blood flow, the arterial and venous pressures, and the size of the heart.

There is an excellent index and a comprehensive bibliography of 483 titles.

This is an unusually well written, authoritative monograph written by an observer who is thoroughly familiar with every aspect of his field. It appears to be superior to any previously published work dealing with blood volume and may be warmly recommended to the student, physiologist or clinician who is especially interested in this subject.

CYRUS C. STURGIS

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, 105 Rutledge Ave., Charleston, S. C.

AN INEXPENSIVE WATER COOLING SYSTEM FOR DEEP THERAPY INSTALLATIONS UP TO 200 KV., EMPLOYING CITY WATER*†

By FRANCIS W. BISHOP, *and* STAFFORD L. WARREN, M.D.

ROCHESTER, NEW YORK

FOR several years we have used a water cooling equipment supplied by the manufacturers as part of the regular deep therapy installation. On April 20, 1932, the main insulator of the system punctured. The cooler originally cost about $1,200 and the repair charge in this instance was estimated at about $400.

We decided to try direct cooling of the tube by city water, a system which we have employed previously in the laboratory during experimental work, but at lower voltages.

Reviewing data from the previous laboratory experiments, it was calculated that about 30 meters (100 ft.) of 12.5 mm. ($\frac{1}{2}$ in.) pressure hose, leading to the tube from

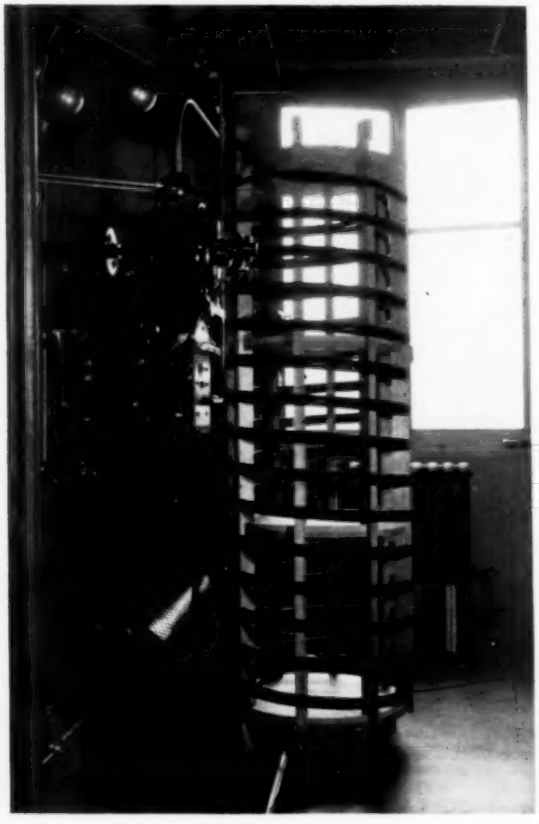

Fig. 1. Showing the winding of double hose on framework.

Fig. 2. General arrangement of mercoid temperature and pressure controls and the pressure regulating device.

* From the Division of Radiology, Department of Medicine of the University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital, Rochester, N. Y.

† We wish to acknowledge the assistance of Mr. Charles F. Alberts in the construction of this apparatus.

the water supply and the same length return from the tube, would supply sufficient water for cooling purposes, with a minimum electrical leak to ground. Accordingly, a framework drum about 2 meters high and 60 cm. in diameter was constructed, with slots in which to wind the double hose. When finished there were fifteen turns of hose, with a space of 12 cm. between turns (Fig. 1). During operation at full voltage there is a potential drop through the hose of 1,000 volts per foot. The 100-ft. length of water-filled double hose has a measured electrical resistance of 16 megohms. The current drain, with one end of the system at 100 kv. peak above ground, is 2 milliamperes. This leak is of no significance since our machine has a capacity of around 50 ma. at 200 kv. peak. The maximum rise noted in the water temperature as it flows through the roentgen tube was 20° C. This was at a time when the water pressure was low, causing a diminished flow. The usual increase is around 10° C.

A mercoid temperature control was installed in the grounded end of the return water line to shut off the machine if the water temperature rises beyond a predetermined limit. A mercoid pressure control was also placed in this same circuit to prevent the machine from being turned on if the water is not on and to shut off the apparatus if the pressure should fall for any reason. There was also an automatic water pressure regulator and filter placed in the incoming line to maintain a constant pressure at the roentgen tube (Fig. 2). It was considered a possibility that there might be mineral deposits from the water laid down in the roentgen tube. Examination of a water filter, which had been in the main line to the hospital for five years, showed little evidence of deposit there. Moreover, the water flowing through the tube is cool so that there should be little or no acceleration of deposit due to temperature. Electrolysis is not considered a factor. To provide a visual check at all times, however, the warmer return water is caused to flow through a length of glass tubing where any deposits can be seen.

The incoming water pressure is usually around 40 lb., while the unimpeded outflowing water registers about 3 oz. The total cost of this water cooling system is less than $100. We expect the hose to deteriorate eventually, but it is easily replaced for less than $20.

SUMMARY

An inexpensive and fully protected water-cooling system for high voltage tubes has been described, which uses the ordinary city water for cooling.

AN AUTOMATIC LOCKING DEVICE FOR ROENTGEN TUBE STANDS AND VERTICAL ROENTGENOSCOPES*

By FRANCIS W. BISHOP
Associate in Medicine
ROCHESTER, NEW YORK

THE Division of Radiology of the Strong Memorial Hospital recently suffered the loss of a roentgen tube and some damage to the tube stand through the spontaneous parting of the cable supporting the tube and counterweight. The tube stand was obviously not locked at the time. The breakage occurred at a soldered junction of the cable and a clevis which was attached to the tube holder by a bolt. Inspection will not necessarily indicate when such a junction is about to part. Furthermore, the connection of the cable to the counterweight is usually concealed. Investigation shows that tube stands are often not clamped by the operators or technicians

* From the Division of Radiology of the Department of Medicine, University of Rochester School of Medicine and Dentistry and Strong Memorial Hospital, Rochester, N. Y.

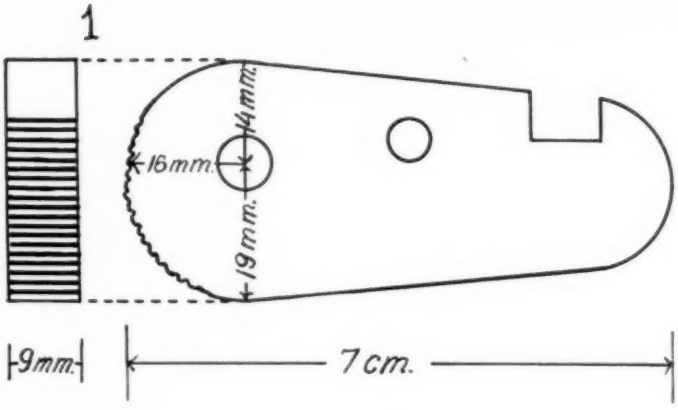

Fig. 1. General appearance of the locking member.

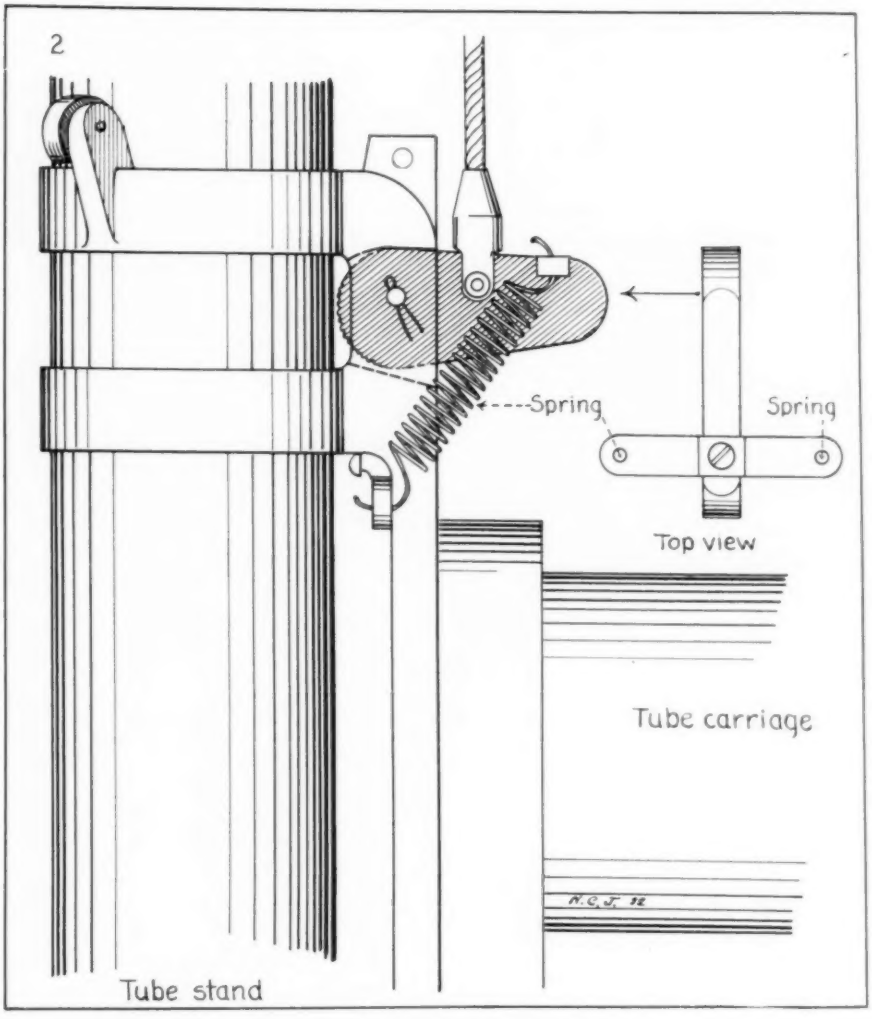

Fig. 2. Detail of automatic lock as mounted on tube stand.

when not in use. It also shows that some of the methods used by the manufacturers to attach the cable to the tube carriages are not entirely safe. There is always the possibility of the breaking of the cable while the tube stand is in use, in which case the operator probably could not prevent the heavy tube carriage and accessories from falling upon the patient. The weight supported by the cables on different tube stands in this hospital varies from 22 kg. (48.5 lb.) to 32 kg. (70 lb.).

In view of these facts, it was deemed advisable to devise some sort of automatic brake which would instantaneously lock the tube carriage in case of such an accident. Accordingly, a small dog was designed (Fig. 1) which turns on an eccentric, bringing into contact with the tube stand a corrugated surface whenever the tension of the cord is interrupted. The locking device is ordinarily pulled against a stop by the tension of the cord. If the cord is broken, the eccentric member is pulled into contact with the tube stand by springs (Fig. 2), where it wedges more and more tightly if the tube carriage tends to move downward. Simple braking action was first tried, but the largest braking area practicable on our stands was not adequate. Tiny teeth were then milled in the brake surface, which does not slide but locks firmly the instant contact is made with the tube stand.

It is necessary to make minor variations in the design of the locking member to adapt it to a particular make of tube stand, but the general principles remain the same (Fig. 3). Numerous tests and demonstrations show that the locking action is positive and certain, the tube carriage dropping a distance of only about 3 mm. ($\frac{1}{8}$ in.) before locking. Since there is no sliding there is only a slight and quite harmless abrasion of the tube stand caused by the operation of the lock. No provision has been made on our stands to care for the fall of the incased counterweight, since the chief purpose of the lock is to safeguard the patient and the roentgen tube.

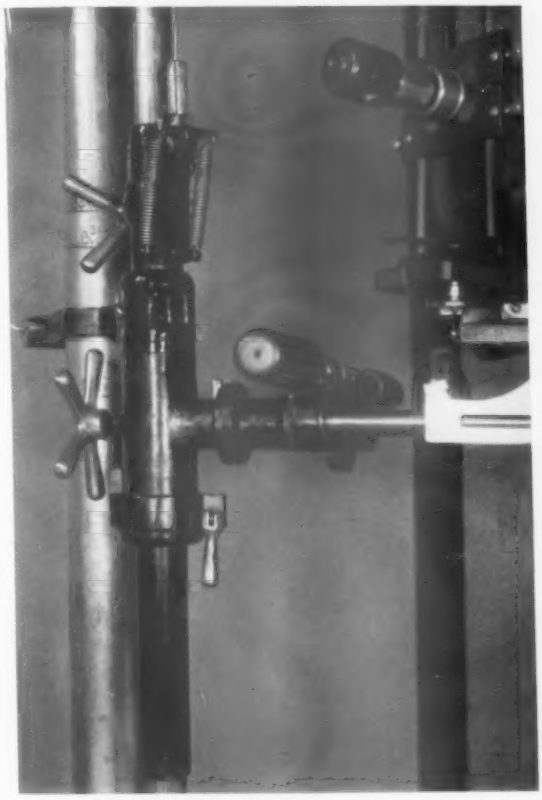

Fig. 3. Close-up of lock on tube stand.

SUMMARY

A simple and inexpensive device has been described which provides the best insurance against damage to a patient or roentgen tube from a probably rare but always potential accident: namely, the fall of the tube carriage due to breakage of the tube stand cord.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

Apert, Duhem, and Biancani. Myosite ossifiante progressive. (Progressive myositis ossificans.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1931, *19*, 93–95.

A case of progressive myositis ossificans which occurred in a girl sixteen years of age is described in detail. The condition started at the age of three following phlegmon of the submastoid region and progressed in stages, each time following inflammatory exacerbation, until it involved most of the muscles. The interesting feature was that the ossification was localized chiefly to the ends of the muscles and that every step in the extension was preceded by an inflammatory spell. This latter would seem to rule out a hereditary origin.—*T. Leucutia.*

Zieliński, Roman. Zwei Fälle von Myositis ossificans progressiva multiplex. (Two cases

of myositis ossificans progressiva multiplex.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1931, *44*, 508–515.

The author describes in detail 2 cases of progressive myositis ossificans using several roentgenograms for illustration. The first occurred in a girl nine years of age, the lesion having started at the age of three with high fever. The stiffness of nearly all parts of the body developed in a progressive manner. In the second, that of a girl eighteen years old, the disease dated back to the age of one, the stiffness having likewise developed in a gradual progressive manner until all extremities, the neck and the spine became involved. The roentgenograms in both instances revealed a condition typical of myositis ossificans.

The etiology is unknown, although a more thorough investigation of the function of the parathyroid glands appears indicated. More recently the unilateral removal of the parathyroids led to successful results in several cases of ankylosing polyarthritis and therefore it would seem worth while to try the same for progressive myositis ossificans. The author has recommended such a procedure in his two cases but in the first the parents objected, while in the second this could not be performed on account of very marked deformity of the neck.—*T. Leucutia.*

Laquerrière and Jaudel. Une ostéoarthropathie curieuse. (A curious osteoarthropathy.) *Bull. et mém. Soc. de radiol. méd. de France*, July, 1931, *19*, 327–328.

The authors, in studying some of their old roentgenograms, found the plates taken in 1902 of an individual forty years of age who presented a chronic arthropathy with osteophytes and osseous hypertrophy lasting for a period of over twenty years, some of the articulations finally leading to complete ankylosis. Clinically there was no pain associated with the lesion. The authors are still unable to satisfactorily classify the condition despite thirty years' additional experience.—*T. Leucutia.*

Arendt, Julian. Ein eigenartiges Krankheitsbild aus der Gruppe endokrin neurotrophischer Osteoarthropathien. (A peculiar disease picture of the group of endocrine neurotrophic osteoarthropathies.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, *45*, 199–206.

The author describes extensively a case by using several roentgenograms and photographs and a photomicrograph for illustration. The condition started at puberty with hard edema of both forearms and hands. Later a similar condition appeared on the legs and feet, resulting in gangrene for which an amputation of both thighs had to be performed. Roentgenograms of the hands revealed marked demineralization with areas of calcium deficiency. The condition was classified as a trophoneurosis occurring no doubt on an endocrine basis.—*T. Leucutia.*

Meyer, Herman F., and Brennemann, Joseph. A rare osseous dystrophy (Morquio). *Am. J. Dis. Child.*, Jan., 1932, *43*, 123–135.

The authors report a case of osseous dystrophy similar to the cases reported by Dr. Howard E. Ruggles in a paper entitled "Dwarfism Due To Disordered Epiphyseal Development" in the January, 1931, issue of the *American Journal of Roentgenology*. The roentgenograms, history of the case, clinical appearance, etc., are identical in nature. Morquio first described the condition. In the case here reported, several of the things that seemed to be of significance in his cases were lacking. Thus, in this case there was no familial tendency. Morquio considers the lowered blood calcium in his cases as of some probable significance in the etiology of the disease. Meyer and Brennemann's case had normal blood calcium values. They can agree with Hodges' view that the condition might be classified as "achondroplasia in the sense that the process is an interference with the metamorphosis of cartilage into bone." But in this sense, they emphasize, that achondroplasia is not the "achondroplasia" or chondrodystophy, that has come into common usage to designate the most common type of dwarfism, a condition which is usually symmetrical with uniform and gross deformities. There are, also, in this case changes that cannot be explained on the basis of achondroplasia alone.

Dr. P. C. Hodges, to whom the roentgenograms were submitted for examination, summarized the roentgen description as follows: "The patient suffers from a generalized skeletal disease that has produced rarefaction of most of the bones visualized, has interfered grossly with the development of the epiphyses and has produced cyst-like deformities at the ends of

certain of the long bones, notably the upper and lower ends of the femora, tibiae and fibulae."—*R. S. Bromer.*

MICHAELIS, LORENZ. Zur Klinik der Systemerkrankungen des Skeletts. (On the clinic of the systemic diseases of the skeleton.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, *45*, 187–199.

The author describes in lengthy detail a case in a man eighteen years of age which started as a result of poor nourishment during the war, with diffuse pain in the feet, and continued later with pain in the legs, knees, hips, pelvis, sacrum, and still several years later with pain along the spine, shoulder, upper and lower arms. The roentgen examination of the entire skeleton revealed a marked calcium defficiency with peculiar areas of band-like zones as if the bone were erased. The involvement extended both to the cortex and spongiosa, and in a few places led to periosteal changes. No deformities were encountered in any part of the skeleton, although the flat and long bones were involved in a like manner, the zones appearing chiefly at the place of the former epiphyseal lines and more rarely within the epiphyses or even diaphysis. A peculiar feature of the condition was that there was a very marked symmetry (mid-portion of the foot, neck of the femur, shoulder, humerus, radius, mid-portion of the hand) and an alternating involvement of the tibia (the upper epi-diaphyseal border being involved on the right side and the lower on the left).

The author was unable to classify this condition although he is under the impression that it might represent some sort of hunger malacia.—*T. Leucutia.*

MAGNUSON, PAUL B. Backache from the industrial standpoint. *J. Bone & Joint Surg.*, Jan., 1932, *14*, 165–169.

Magnuson makes a plea to have physicians and surgeons examine their own mental attitude before they start to examine a back in an industrial case. The examination is not made for an employer to prove his point or for an injured man to prove his contention. The effort should be made to determine whether there is pain in the back, whether this pain could be due to the injury claimed, or whether it could be due to the injury claimed plus some preëxisting conditon, or whether it is the result of something inherent in the patient's body which has caused pain in the back without injury.

Thus the surgeon becomes a diagnostician and not à partisan in a law suit. Good reasons should be had for statements advanced and these statements should be backed up with findings which can be substantiated. Experience in examining backs of private patients is valuable for the man who examines backs from the industrial standpoint because of the psychological differences in the two classes of patients. In Magnuson's experience the true malingerer is infrequent in industrial practice. It is true that many patients exaggerate their symptoms, but this is on the same basis that the claims departments and the company surgeons minimize the symptoms. Claims departments in his experience have always kept their agreement to stand by the opinion rendered in an examination. In order to avoid misunderstandings, the examiner in reporting examinations should set down definite reasons for his findings—whether for or against injury—and analyze the case so that the attorneys who read the report will know what the doctor's mental processes are and why he has arrived at certain conclusions.

Magnuson describes in detail his method of examination. He makes ingenious use of a pressure meter for measuring sensibility to pain, tenderness, etc. He believes the interpretation of roentgenograms in these cases of industrial backache has been the cause of bitter arguments. The clinician many times does not make a diagnosis in cases of backache because the roentgenologist will not tell what is the matter with the patient. The roentgen rays he regards as of minor importance in a large percentage of the cases. There are few individuals who have suffered any of the consequences of living who do not have some evidence of so-called arthritis in the spine. If roentgenograms were held up for examination in these cases, the patients would be considered unfit for any sort of labor, and yet they have no symptoms. On the other hand, many acute inflammatory processes in bones, joints and ligaments show no roentgen changes. The fact that such a condition shows in the roentgenogram means that it has been there for a long time and, if the patient has been working for months, it is certain that he has been working with the same condition that is shown in the roentgenogram. Therefore, the condition which is causing the trouble must be a more or less acute affair.—*R. S. Bromer.*

Delahaye, A. Signes radiologiques de l'épiphysite vertébrale douloureuse des adolescents. (Roentgen signs of painful vertebral epiphysitis of adolescents.) *J. de radiol. et d'électrol.*, Dec., 1931, *15*, 665–670.

Vertebral epiphysitis of adolescents is observed most frequently at the level of the middle and lower dorsal spine, giving a rather typical roentgen image. In studying the development of the vertebrae between the ages of fifteen and twenty-five, the author made comparison with the developing spine of the calf. Thus he found that the vertebral epiphyses of this latter are similar to those observed in adolescent humans, except that their form is platelike, whereas in the human they appear biconcave, annular, or often perforated in the center. The anomaly of the process of ossification which characterizes painful vertebral epiphysitis is not localized exclusively to the epiphyses. The adjacent cartilages as well as the juxta-epiphyseal zones of the vertebral bodies and in the more advanced cases even the central mass of the spongiosa are nearly always altered. The roentgen appearance varies according to the three anatomic stages of evolution: (1) In the first stage, characterized by decalcification and a delayed appearance or entire absence of the epiphyseal points, the vertebral borders are hazy and the central spongious mass often cloudy, the picture being very much like that of a bony softening. (2) In the second stage, characterized by local recalcification, a veritable cicatrization occurs manifesting itself in the form of dark bands, particularly at the vertebral borders in the immediate vicinity of the epiphyseal and juxta-epiphyseal zones. (3) The third stage is dominated by the anatomic sequelae, some of which are the immediate and direct sequence of the localized cicatricial alterations, and others secondary to an overweight, leading to deformity such as kyphosis. This latter may be prevented or corrected if a logical orthopedic treatment is instituted in time. If no attention is paid to the process and the overweight results in a cuneiform compression of the vertebral body, treatment may prove entirely inefficacious. Thus the conclusion is drawn that an early diagnosis before the setting in of kyphosis is of paramount importance from a therapeutic standpoint.—*T. Leucutia.*

Tscherepnina, M., and Michajloff, M. Über deformierende Prozesse in den Epiphysenwinkeln der Wirbel. (On deforming processes in the epiphyseal borders of the vertebrae.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Jan., 1932, *45*, 92–103.

The authors designate under the name of epiphyseal borders of the vertebrae those parts of the annulus fibrosus of the intervertebral disc which lie on the anterolateral surface along the bony border of the fully developed vertebral bodies. In making a systematic study of the specimens of 115 vertebral columns, in 65 cases microscopic and in 44 roentgenologic changes were found in this region. The changes are described and discussed in detail. It was thought that as a whole they might have a claim to the term of "deforming spondylitis." Since they occurred chiefly in elderly persons affected with arteriosclerosis and certain blastomycetic processes, it was thought that they were the result either of an abnormal enchondral ossification of the vertebral bodies or of an abnormal union of the osseous nucleus with the vertebral body. The provoking factors must be no doubt sought in the special conditions brought about in the static of the vertebral column, the greatest weight bearing occurring chiefly at the borders of the vertebral bodies, that is, in those places in which the deforming processes are more apt to occur. No parallelism was observed between the deforming processes of the epiphyseal borders of the vertebrae and those of the intervertebral discs. It is concluded, therefore, that the described changes represent no separate nosologic entity, but that etiologically they are the result of various diseases or of a disturbance of the enchondral growth.—*T. Leucutia.*

Reisner, Alfred. Unterscheidungsmerkmale normaler, entzündlicher und posttramuatischer Zustände an der Wirbelsäule. (Signs of differentiation of normal, inflammatory and post-traumatic conditions of the vertebral column.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 726–751.

I. Introduction. The material includes 3,500 cases of examinations of the spine made during the past six years.

II. Technique. The films were taken in two positions by making stereoroentgenograms whenever possible. The author found very valuable the shifting of the tube with 1/10 of the focal skin distance both in the longitudinal and transverse plane of the spinal column when making stereoscopic exposures. For certain

segments of the spine, as for example, atlas, fifth lumbar, or for the various portions of the individual vertebrae, as for example, demonstration of the intervertebral joints, transverse section of the sacral canal, etc., special procedures were necessary.

III. Importance of knowledge of rarer abnormal findings and morbid conditions. (A) Lumbar ribs. (B) Accessory ossification nuclei, as for example, at the tip of the spinal or transverse processes, end of the ribs, lateral aspect of the vertebral bodies and sacrum, etc. (C) The roentgen appearance during the period of growth. (1) Scheuermann's disease or kyphosis dorsalis adolescentium. This is characterized by three stages: (*a*) the stage of irritation (also called painful epiphysitis of adolescents); (*b*) the stage of deformities, and (*c*) the stage of repair. (2) Vertebra plana necrotica or ostéochondrite vertébrale infantile Calvé. The features of this condition are (*a*) that it affects exclusively children; (*b*) that it is always localized to one single vertebra, and (*c*) that clinically it leads to painful gibbous formation. (D) Gap-like translucencies. Gap formations in the vertebral column as a rule indicate a sequel of trauma; however, not infrequently such formations are encountered on a congenital basis, occurring chiefly in the arches or the spinal processes. Their knowledge is very important from the point of view of differential diagnosis. One may include in this group spondylolisthesis of the fifth lumbar vertebra and the blood vessel notchings which are observed in children in the midportion of the anterior aspect of the vertebral bodies, but which also may occur at a later age, the so-called persisting vessel canals (or the Hahn gaps). (E) Wedge-shaped deformity of the vertebral body. This may be congenital or may represent the end-result of various pathologic conditions. The wedge may be either in the anteroposterior or lateral view.

IV. Signs of differentiation in inflammatory and post-traumatic conditions. In dealing with this chapter the author arrives at the conclusion that a roentgen examination does not suffice to make a differential diagnosis between inflammation and a post-traumatic condition and that often the clinical findings as well as the history and the course of the disease must be taken into consideration.

There is a voluminous literature appended.—*T. Leucutia.*

BERIEL, L., and KAPSALAS, G. A propos du diagnostic entre les tumeurs intrarachidiennes et le mal de Pott. (Regarding the diagnosis between intraspinal tumors and Pott's disease.) *Bull. et. mém. Soc. méd. de hôp. de Par.*, June 8, 1931, *55*, 949–952.

This is a report of a case of Pott's disease which was diagnosed spinal tumor. An autopsy examination is included. Repeated roentgenograms were negative, but a paravertebral osseous tuberculosis was found. The conclusion is made that there are certain forms of medullary compression by Pott's disease which cannot be differentiated from certain tumors of the canal. Two illustrations are included in the report.—*Ellsworth Johnson.*

ELJASCHEW, L. I. Ueber die chronischen Knochenabszesse (Brodie). (On chronic bone abscesses (Brodie).) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Dec., 1931, *44*, 758–766.

In reviewing the rather vast literature dealing with the various aspects of Brodie's abscess, the author found that there is a marked contradiction concerning the localization, pathologic anatomy, clinical appearence, and even the diagnosis of this condition. To solve the problem he proposes that the relation of the virulence of the bacterial agent to the general and local immunity of the organism be made a basis of consideration. With this view in mind, he made a diagram by plotting the virulence of the agent on the abscissa and the general and local immunity on the ordinate of a coordinate system. The various forms of bone infection are then placed on the intersecting line, beginning with the absolute immunity, which is at the zero point, and following with osteomyelitis scleroticans, Brodie's bone abscess, osteomyelitis chronica, osteomyelitis albuminosa and terminating with osteomyelitis acuta which is at the top of the line.

Four cases of Brodie's abscess are briefly described and discussed to prove that a transition into any of the neighboring forms of the above scheme is possible.—*T. Leucutia.*

KLEIN, IRWIN J. Hereditary ectrodactylism in siblings. *Am. J. Dis. Child.*, Jan., 1932, *43*, 136–142.

Hereditary malformations of the extremities of various types in human beings have been described in the literature under such terms as syndactylism, polydactylism, brachydactyl-

ism, ectrodactylism, macrodactylism, hyperphalangism and hypophalangism. Other malformations of the extremities reported to be hereditary are such conditions as fragilitas ossium, cartilaginous exostosis and club-foot.

The anomaly presented by Klein in this paper is known as ectrodactylism or the absence of fingers. This occurred in siblings of the same sex, with superficial and roentgenographic evidence of identical deformities. The antecedents for three generations were normal. The parents were normal in health. They were related as uncle and niece, i.e., the father and the mother's father were half-brothers on the father's side, though each had a different mother. The first child, a girl aged seven, was normal in every way. The second, a boy, five and one-half years of age, had a normal birth history and was normal except for deformity of both hands. The third child, the patient, aged three weeks, had the identical deformity of both hands that the brother had.

The roentgenograms of the youngest child's hands showed three metacarpal bones. The digits were markedly deformed and but three were present, with a rudimentary fourth which fused with the middle digit so that clinically it appeared as but one finger. No appreciable deformity of the metacarpals was present. On clinical examination the feet showed slight webbing at the base, but five normal toes were present on each foot. Roentgenograms of the older brother's hand showed the same deformity. The findings were bilateral in both brothers.

Inherited hand deformity is generally a dominant trait, and a dominant trait cannot appear in any child unless present in any one or both parents. This is in contradistinction to a recessive trait, which may skip one or more generations and appear when neither parent shows the character. As far as Klein has been able to trace, there was no previous family history as to any similar deformity, and the parents were likewise free from abnormality. Therefore, one of the possibilities to be considered is that a new mutation arose in the germ cells of either the father or the mother, and appeared in the sons. This case would then present a new mutation of what is usually considered a dominant trait. Another possibility is that each of the parents carried the gene for the same anomaly as a recessive trait, because if two such germ cells united, the trait would be expressed. This possibility must be considered because the parents were blood relatives. In that event, it would be necessary to consider this unusual, because here the deformity was inherited as a recessive trait, whereas hand deformities are usually dominant traits.—*R. S. Bromer.*

Harris, H. A. Lines of arrested growth in the long bones in childhood: The correlation of histological and radiographic appearances in clinical and experimental conditions. *Brit. J. Radiol.*, Nov., 1931, *4*, 622–640.

Summary. Lines of arrested growth have been shown by roentgen examination to be of frequent occurrence both in animals and plants. In man, at the time of cessation of growth in the long bones, during the eighteenth to the twentieth years, such lines are normally laid down. In neo-natal life, as a result of the catastrophic changes involved at birth, an arrest of growth concomitant with the loss of weight in the first week of life is of such frequency as to be almost a normal feature. During the whole period of growth any severe interference with metabolism, either as a result of starvation, acute infection, or metabolic disease such as diabetes, induces premature senescence in growing tissues, and the fact is unfailingly registered in the structure of the bone by the production of a transverse line of arrested growth.

The phosphorus line of Wegner, the arsenic line of Gies, and the various lines described in man and animals are, like the lines of the scale of the salmon, the lines on teeth and the lines the nails strictly comparable to the varying lines seen in trees. But whereas the trees with their stationary habitat, and fish with their fixed migrations and seasons, tend to show variations which are mainly seasonal, man with his control of environment has tended to manifest those arrests of growth which largely result from that heritage of disease of which he is a victim. If Metchnikoff's theory of orthobiosis were to become an accepted fact, the protection of the individual against infection would result in the lines of arrested growth in bone becoming as rare as the other manifestations of infective diseases. On the other hand, the line of healing rickets is peculiar to a single disease, occurs in particularly circumscribed age groups associated with rapid growth, and is relatively rare in clinical practice as a result of the rapid decrease in the incidence of severe rickets. It is unfortunate that in much of the experimental work on rickets the widespread occurrence of

lines of arrested growth has been ignored.—*T. Leucutia.*

D'AUBIGNE, MERLE. Le réduction des fractures de jambe par traction mécanique sous l'écran radiologique. (The reduction of fractures of the leg by mechanical traction under roentgen screen.) *Presse méd.*, Dec., 23, 1931, *39*, 1891–1894.

The reduction of fractures under roentgenoscopic control is now generally advised. The method is exceedingly simple in fractures of the ankle and wrist, but somewhat more difficult in the diaphyseal fractures of the tibia and fibula, whether of the transverse or spiral type. From a very large experience the author found that the use of an extension apparatus, embodying the principle of mechanical traction, during the roentgenoscopic reduction and application of the cast helps to overcome all difficulties encountered. In this article the apparatus as well as the method of procedure is described in detail, several photographs being used for illustration.

Briefly the apparatus comprises a device for counter-extension and one for the actual traction. The first consists of a strong rubber tube (rendered incapable of extension by a cable in its mid-axis) which is placed in the genitocrural groove and fixed by means of bands to one extremity of the roentgenoscopic table. The second consists of a screw provided with a flywheel which is fastened to the other end of the table. The foot is attached to the screw by means of a tackle provided with two bands for support, one passing under the achilles tendon and the other on the dorsum of the foot. The intercallation of a dynamometer has shown that a traction of 50 to 60 kilograms can be exercised during the reduction. At the beginning, general, later, spinal anesthesia was used, but recently both were given up in favor of local anesthesia, which is more satisfactory. It is essential, however, that the anesthetic solution be injected in the hematoma around the fracture. In case of difficulty, roentgenoscopic control can be used to be as certain that the needle has reached the fracture area. As a rule 10 c.c. of 2 per cent novocain is injected on each side. The fracture is then reduced by the mechanical traction (turning the flywheel of the screw) and fixation applied. In this respect the author prefers to use for the first fourteen days a lateral mold which is placed on one side of the leg and carried through the sole to the other side, a cut being made at the heel for the traction bands. The lateral mold is held in position by two circular molds, one placed below and the other above the fracture. The preparation of the lateral and circular molds is illustrated diagrammatically. Later a cast is applied.

The method was used in 52 instances with excellent results. In only 2 cases was it necessary to resort to an open operation later, in both instances the fracture having lasted for a longer period. If the reduction is made within the first twenty-four hours it should succeed in every instance. The author expresses the view that the method may be used also in compound fractures, except of course that the wound is treated in the usual way.—*T. Leucutia.*

BALESTRA, GIOVANNI. Delle alterazioni osteoarticolari ed ossee nella syringomielia. (Bone and joint lesions in syringomyelia.) *Radiol. med.*, Dec., 1931, *18*, 1515–1540.

Joint changes in syringomyelia are distinctly more frequent in the upper limbs, changes in the shoulder and elbow joint being most frequent, followed in order by those in the wrist and finger joints and in the lower libs. The beginning is generally acute with swelling and turgor of the soft parts and joint effusion. Pain is slight in proportion to the swelling. Both atrophy and hypertrophy of the joint heads are seen and sometimes a combination of the two. In the hypertrophic form the joint heads are irregularly enlarged and deformed by osteophytes. The capsule is thickened, adherent to the bone and ossified, while the surrounding soft parts are infiltrated or ossified. Sometimes there are such changes in the surrounding soft parts whithout any true involvement of the bone. In the atrophic form there is rarefaction of bone, which may extend to complete absorption of a joint head. There may also be stretching of the capsule, elongation and insufficiency of the ligaments and changes in the relations of the muscle tendons.

Among the complications of syringomyelia are phlegmons and felons, which may cause deformity and mutilation of the hands. Fractures are frequent, particularly of the radius and ulna Bone necroses are also characteristic. Scoliosis, kyphosis and kyphoscoliosis of the spinal column are often seen. Four typical cases are described and illustrated with roentgenograms.

One of the most important points in roentgen examination is differentiation between syringo-

myelia and tabetic arthropathy. The atrophy and hypertrophy of bone and the changes in the periarticular tissues that are seen in syringomyelia are also seen in tabes. But in syringomyelia the atrophic form predominates in the shoulder while the hypertrophic form, more or less associated with atrophy, is seen in the other joints. In tabes the atrophic form is seen in the hip and shoulder joints and the hypertrophic form in the knee, ankle and elbow. There are no really pathognomonic signs of the two diseases but new formation of bone is more marked in tabes. The tabetic foot is characteristic and not apt to be confused with that of syringomyelia. It is a flat foot when the lesions are localized in the tarso-metatarsal region and a pes cavus when the metatarsals and phalanges are also involved. The first type is by far the most frequent. It is hard to differentiate between the two diseases clinically but phlegmons and skin ulcerations are more frequently seen in syringomyelia. As stated above, syringomyelic lesions are more frequent in the upper limbs while tabetic arthropathy generally develops first in the lower limbs. Spontaneous fractures are apt to be symmetrical and bilateral in tabes while in syringomyelia they are not. The spinal changes in syringomyelia are more apt to involve the whole column while in tabes they affect only the lumbar or lower dorsal column. Roentgen examination is valuable in showing foci of necrosis which are not manifest clinically. They are more frequent in syringomyelia than in tabes.—*Audrey G. Morgan.*

Reich, Rudolph S. Traumatic dislocation of the shoulder. *J. Bone & Joint Surg.*, Jan., 1932, *14*, 73–84.

It is usual to describe two main types of dislocation at the shoulder, subspinous and backward, and subcoracoid or forward dislocation. In Reich's material he found but 3 cases of subspinous dislocation. This paper is concerned chiefly with the frankly traumatic type comprised under the general heading of subcoracoid dislocation. The study of his specimens has led him to formulate the following classification:

A. Congenital anomaly	Backward dislocation (subacromial, subspinous)
B. Traumatic defects	
Subluxation	I. Stub
Luxation	II. Subcoracoid dislocation
Complication	III. Subglenoid dislocation
	Arthropathy following dislocation.

Reich's study leads him to believe that the classic description of production of traumatic shoulder dislocation is not borne out by his cases. In the original injury the humeral head has been forced over the glenoid margin in the subscapular bursa. This is accompanied by either a stubbing fracture of the ventral glenoid margin or by a functional disability of the subscapularis muscle, or both. In the subluxation or stub, the healed glenoid margin is no disability but the functional damage sustained by the subscapularis becomes the important feature. The humerus is externally rotated and is slightly eroded on its dorsal aspect adjacent to the greater tuberosity, even though the head never leaves the glenoid cavity. This condition may escape notice or be diagnosed as rheumatism.

Subscapularis bursitis seems to have some influence in predisposing the joint to traumatic dislocation through thinning of the glenoid margin. In the true luxations the head leaves the glenoid and the final category depends upon the site of glenoid injury. If the mid-ventral margin is damaged, subcoracoid dislocation results; if the lower ventral margin is damaged, subglenoid dislocation results. In such conditions the humeral erosion is more or less deep, depending upon the extent of glenoid damage and muscular action. This humeral erosion apparently continues long after the original pain and muscular spasm have given place to "rheumatism" and muscular contracture.

Stubbing fracture of the ventral margin of the glenoid, old synovitis of the subscapularis bursa, and traumatic functional deficiency in the subscapularis muscle are the three contributing causes to traumatic dislocation of the shoulder, so far as can be ascertained from his material. Inasmuch as many of the cases which Reich describes, especially those classified as stub, were cases of recurring subluxations of the shoulder joint, he recommends that operative correction should be planned with the view to correction of the subluxation by check ligaments and bone-block operations rather than by capsulorraphies.—*R. S. Bromer.*

Neumark, S. Zur Kenntnis der spätsyphilitischen Gelenkerkrankungen. (On the knowledge of late syphilitic joint disease.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Oct., 1931, *44*, 481–497.

The diagnosis of syphilis of the joint is very

difficult both from a clinical and roentgenologic standpoint. A confusion with tuberculosis, rheumatism and deforming processes occurs not infrequently. The roentgenograms may appear entirely negative when there are severe clinical manifestations or, vice versa, they may show marked changes when the clinical findings are hardly discernible. Generally, one is unable to make a diagnosis on the basis of the roentgen examination alone unless there is association with some other more typical luetic lesions as, for example, multiple periosteal deposits with intensive bone sclerosis, absence of Sudeck's acute bone atrophy, localization to one single bone or to one single surface of the joint over a longer period, gummatous destructive processes (especially in hereditary lues), etc. The clinical manifestations, the course of the disease, and the serologic tests of the blood and joint fluid will then further aid in substantiating the diagnosis.

The author briefly describes 22 cases of joint syphilis, using 12 well-selected roentgen diapositives for illustration. The more or less characteristic signs in the individual cases are discussed and the differentiation from tuberculosis and deforming joint lesions as well as from tabetic arthropathia is considered.—*T. Leucutia.*

GALDAU, D. Deux cas d'ostéochondrite disséquante a localisation insolite. (Two cases of osteochondritis dissecans with unusual localization.) *J. de radiol. et d'électrol.*, Oct., 1931, *15*, 567–568.

The classical site of osteochondritis dissecans is the articulation of the knee and less frequently the articulation of the elbow. Several cases with atypical localizations have been reported recently. The author wishes to add 2 further cases of his own. In one the lesion occurred in the left coxofemoral joint and in the second at the upper surface of the tibia within the articulation of the knee. This latter showed multiple fragments and was on a tabetic basis.

The opinion is expressed that in the presence of osteochondritis dissecans with atypical localization and multiple fragments one should always bear in mind the possibility of arthropathy.—*T. Leucutia.*

BURMAN, M. S., and POMERANZ, M. Epiphysitis of the proximal epiphysis of the first metatarsal and of the first phalanx of the big toe; coincidental presence of proximal or pseudometatarsal epiphyses. *J. Bone & Joint Surg.*, Jan., 1932, *14*, 177–180.

Burman and Pomeranz report a case of bilateral disease of the proximal epiphyses of the first metatarsals and first phalanges of the big toe (epiphysitis), associated with pseudo-epiphyses of the second, third, fourth and fifth metatarsals, bilaterally. The roentgenographic findings in the patient, a boy, aged four, were compression and condensation of the proximal epiphyses of the first metatarsal and of the first phalanges. A little rarefaction was also noted the picture being similar to Köhler's disease of the scaphoid. A later series of films showed an advance in the process; still later films, showed subsidence of the disease with disappearance of the fragmentation which had shown on the second series of films. On the final films the epiphyses consisted of single segments of bone and the osteitis had completely subsided. The accessory centers of ossification in the distal ends of the second metatarsal bones on both sides had fused and formed one large epiphysis.

The epiphyses for the metatarsal bones usually appear at four to five years of age, that of the first metatarsal being placed at the proximal end of the bone, those of the remaining four at the heads of the bones. Occasionally, and with sufficient frequency so as not to be rare, epiphyses are noted at the bases of the other metatarsals, those for the second and fifth being seen most often. These accessory or pseudo-epiphyses may be regarded as having no particular significance, save that of an interesting anomaly, or they may be considered as evidence of retarded ossification endocrinally arisen.

The association of the pseudo-epiphyses of the second, third, fourth and fifth metatarsals with bilateral epiphysitis of the proximal epiphyses of the first metatarsals and first phalanges, the authors regard as most probably incidental and of no significance.—*R. S. Bromer.*

MITMAN, M. Köhler's disease of the metatarsal head. *Brit. J. Radiol.*, Feb., 1932, *5*, 115–119.

Three cases of the above-named condition were observed at Guy's Hospital within a fortnight of each other and 2 others were collected from the hospital records, making a total of 5. These cases were studied in detail and while it was found that the statistical features of the

disease coincided more with the findings of Köhler, the author agreed more with Panner concerning the sequence of the pathological appearances. The following résumé of the changes follows closely the description of Panner: The condition appears to be especially an abnormality in the ossification of the epiphysis of the head of the metatarsal, most commonly the second, occasionally the third. It commences usually between the ages of ten and sixteen, the primary changes being in the structure and contour of the epiphysis. The first consist in the appearance of a small nucleus of condensation, the latter in the flattening and shortening of the head and the presence of an ill-defined epiphyseal line. One of the most striking features is the widening of the joint space, which is often more marked on the outer side. The next stage consists in the progressive ossification of the epiphysis and its union with the diaphysis. After this, secondary changes appear in the metatarsal and in the metatarso-phalangeal joint. In the metatarsal, periosteal stratification is rapidly followed by an increase in bone density. The widening of the shaft begins distally and spreads proximally, the ultimate effect being that the whole bone from head to base is thickened and dense. The changes in the metatarso-phalangeal joint consist of an arthritis deformans.—*T. Leucutia.*

Zchakaja, M. J. Blutversorgung der Knochen des Fusses (Ossa pedis). (Blood supply of the bones of the foot (ossa pedis), *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Feb., 1932, *45*, 160–176.

This article gives in minute detail a description of the blood vessels of all bones of the foot by paying special attention to the following factors: number, character and caliber of the supply vessels of every bone, the variation in their number, the topography of the foramina nutritia, the angulation under which the vessels enter the bones and their subsequent ramifications, their anastomoses, the character of the blood supply during ossification, and the variations of the supply of the different portions of the individual bones. The examination was based on a material of 68 specimens of the lower extremities, from the age of seven months to sixty-five years. The method consisted in injecting the popliteal artery with Hauch's opaque mixture, by taking subsequent roentgenograms and then analyzing the bones individually after removal of the periosteum. Numerous roentgenograms are used for illustration. —*T. Leucutia.*

ROENTGEN AND RADIUM THERAPY

Weber, Karl. Über Totalbestrahlingen bei Hautkrankheiten. (Total irradiation in skin diseases.) *Strahlentherapie*, 1931, *41*, 286–295.

In these total irradiations a Metwa-Metalix tube was used; with a distance of 160 cm. the diameter of the irradiated field was 130 cm. On each irradiation a dose of 15 R was given, with 120 kv., 4 ma. and 3 mm. aluminum filter, with a half-value layer of 0.15 mm. copper or 3.64 mm. aluminum. All measurements were made with Küstner's apparatus and tested with the Hammer dosimeter. The patient was given an irradiation on the front of the body on the first day and on the back on the third day and so on alternately until 8 more irradiations had been given; then after an interval of eight days 4 more irradiations were given, making a total of 12 total irradiations in four weeks. In some cases the whole cycle or part of it was repeated after three weeks.

Fifty-five patients were irradiated, including 22 cases of psoriasis, 30 of eczema, 2 of lichen ruber planus and one of neurodermatitis. In 5 cases there were signs of roentgen sickness which were so severe in 2 cases that the treatment had to be stopped. In the other 3 cases the symptoms were slight and none of the other patients suffered any discomfort at all. Of the 22 psoriasis cases 10 were cured, 5 improved and 7 unaffected. They were all chronic recurrent cases. Among the 30 eczema cases 12 were cured, 9 improved and 9 unimproved. The one case of neurodermatitis and the 2 of lichen ruber planus were cured.

The blood picture was controlled in all the cases. In 9 there was leucopenia; in one case the leucocyte count fell from 7,000 to 2,700. In the other cases the fall was from 6,000–8,000 to about 4,000. In about six to eight weeks the leucocyte count returned to normal. None of the patients that had leucopenia had roentgen sickness. There was no connection between the leucopenia and the results of treatment.

The effects were very striking in eczema; two-thirds of the cases were cured or improved. In extensive eczema therefore total irradiation is to be preferred to local irradiation. The action is a general one. It is hard to say just when total irradiation is indicated for it has brought about

cure in cases which had proved refractory to local irradiation and the reverse has proved true in some cases. In some cases both will have to be tried to see which is best. But at any rate total irradiation gives good results that have so far proved permanent.—*Audrey A. Morgan.*

KISSMEYER, A. Anwendung der Buckystrahlen in der Dermatologie. (Use of Bucky rays in dermatology.) *Acta radiol.*, 1931, *12*, 289–299.

The author gives a review of the present conception of the physical and biological nature of the grenz rays and the theoretical and practical considerations on which their use in treatment is based. His own experience in the treatment of a large number of cases of superficial dermatosis with the rays has convinced him that the use of the super-soft roentgen rays (1 to 3 Å and a half-value layer of 0.014 to 0.03 mm. aluminum) is a method that is apt to prove of great value in the treatment of skin diseases.

There seems to be little if any danger to the skin, the only disadvantage being a pigmentation. Accurate dosage in R units is an absolutely necessary condition for the use of the rays. The author has given 225 to 550 R in eczema and has had extraordinary results in many cases of psoriasis with a dosage of 365 to 825 R (9 kv. maximum and 10 ma.). If one treatment is not sufficient another one can be given after two or three weeks.—*Audrey C. Morgan.*

POKORNY, ADOLF, and POKORNY, LILLY. Bleimasken zur Abdeckung. (Lead masks for protecting the skin.) *Strahlentherapie*, 1931, *41*, 767–770.

It is often very difficult to protect the skin in irradiating lesions of the face where some of the surfaces are convex and some concave. This is particularly true of rodent ulcers of the nasolabial folds, eyelids and angles of the eyes. The authors describe a method of making lead masks for use in such cases. The patient is laid on the table in such a position that the part to be irradiated is as nearly horizontal as possible and all of the skin that needs to be protected is rubbed with vaseline. Places covered with hair, such as the eyelids and eyebrows, must be particularly well greased or removing the cast will be painful. If the mask is to cover the ears or nose the external meatus and nostrils must be filled with cotton tampons rubbed with vaseline so the plaster will not enter the openings. Plaster of a viscous consistency is then applied and allowed to harden. When the negative is removed the inside of it is washed with soapsuds and filled with plaster. The soapsuds keeps the positive from adhering to the negative. When the positive is removed it is covered with a plate of lead 0.5 to 1 mm. thick which is carefully pressed into all the folds and indentations, making an exact mask of the face. The part to be irradiated is then drawn on the surface of the mask and cut out. This mask affords perfect protection. The method requires time but is particularly useful in cases in which repeated series of irradiations have to be given.—*Audrey G. Morgan.*

LÖW-BEER, A., and REISS, M. Der Einfluss der Röntgenstrahlung auf den Stoffwechsel des Jensensarkoms. (The effect of roentgen irradiation on metabolism in Jensen sarcoma.) *Strahlentherapie*, 1931, *42*, 157–159.

Jensen sarcomas were implanted under the skin of rats and irradiated with 120 kv., 4 ma., 30 cm. focus-skin distance and 4 mm. aluminum filter, about 650 R being given at one time. Metabolism was studied by Warburg's method, using Ringer's solution for glycolysis. The metabolism determinations were made one to five days after irradiation before any demonstrable changes had taken place in the tumors. Biological changes in metabolism are probably the first phase of the destructive action of the rays. It was found that the process of oxidation is considerably decreased by irradiation and the excess of fermentation is increased. The energy requirement, even in untreated tumors, is covered to a certain extent by fermentation and this is true to a still greater degree in irradiated tumors.—*Audrey G. Morgan.*

CHAMPEIL and TILLIER, R. Radiothérapie dans les sinusites fronto-maxillaires. (Radiotherapy in frontal maxillary sinusitis.) *Bull. et mém. Soc. de radiol. méd. de France*, Oct., 1931, *19*, 420–422.

Three cases of sinusitis which were successfully treated by roentgen irradiation are briefly described. The doses employed were extremely small, from 300 to 450 R per seance, given with 0.2 mm. Cu and 10 mm. Al filters, 30 cm. spark gap, 2.5 ma.—*T. Leucutia.*

ACTION OF ROENTGEN RAYS AND RADIUM

ON THE

HEART AND LUNGS

EXPERIMENTAL DATA AND CLINICAL RADIOTHERAPY

BY

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MAYO CLINIC

ROCHESTER, MINNESOTA

SECTION NINE

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ACTION OF ROENTGEN RAYS AND RADIUM ON THE HEART AND LUNGS

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